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New Lock and Canal at "The Soo"

SYNOPSIS—The construction of a ship lock 80x1350 ft., with concrete walls 50 ft. high, built in monolithic masses or blocks 30 ft. long, necessarily presents many special features and points of interest. This construction work is dealt with in the accompanying article, which deals also with some of the other improvements in connection with the navigation of the St. Mary's River at the "Soo."

An immense ship lock 80x1350 ft. is being built at Sault Ste. Marie, Mich., to give increased facilities for the very heavy traffic through the St. Mary's River, which forms the channel connecting Lake Superior with the lower lakes. Auxiliary to this is the construction of a new canal and approaches, which will serve also a duplicate lock, the excavation for which has been commenced. The general scheme of improvements at this point was described in an article in ENGINEERING NEWS of March 5, which described also the design of the lock, with its great gates, its electric operating machinery, and other features. The present article deals more particularly with the construction work and plant at the lock and its approaches, but includes also the power plant, the river-regulation works, and other auxiliary features of the improvements, together with some statistics of the enormous navigation traffic at this point. The plan, Fig. 2, shows the existing works and the additional works now being carried out.

The work is under the direction of Lieut.-Col. Mason M. Patrick, Corps of Engineers, U. S. A., as engineer officer of the district which includes the "Soo." The operation and maintenance of the present facilities, and also the construction of the additional facilities, are under the direct charge of Louis C. Sabin, General Superintendent of the St. Mary's Falls Canal. For the new work, W. J. Graves and I. De Young, Assistant Engineers, have done much of the designing and are in immediate charge of the construction.

The Great Lakes Dredge & Dock Co., of Chicago, has the contract for the concrete work of the new lock (No. 3) and for the construction of the lower entrance for the

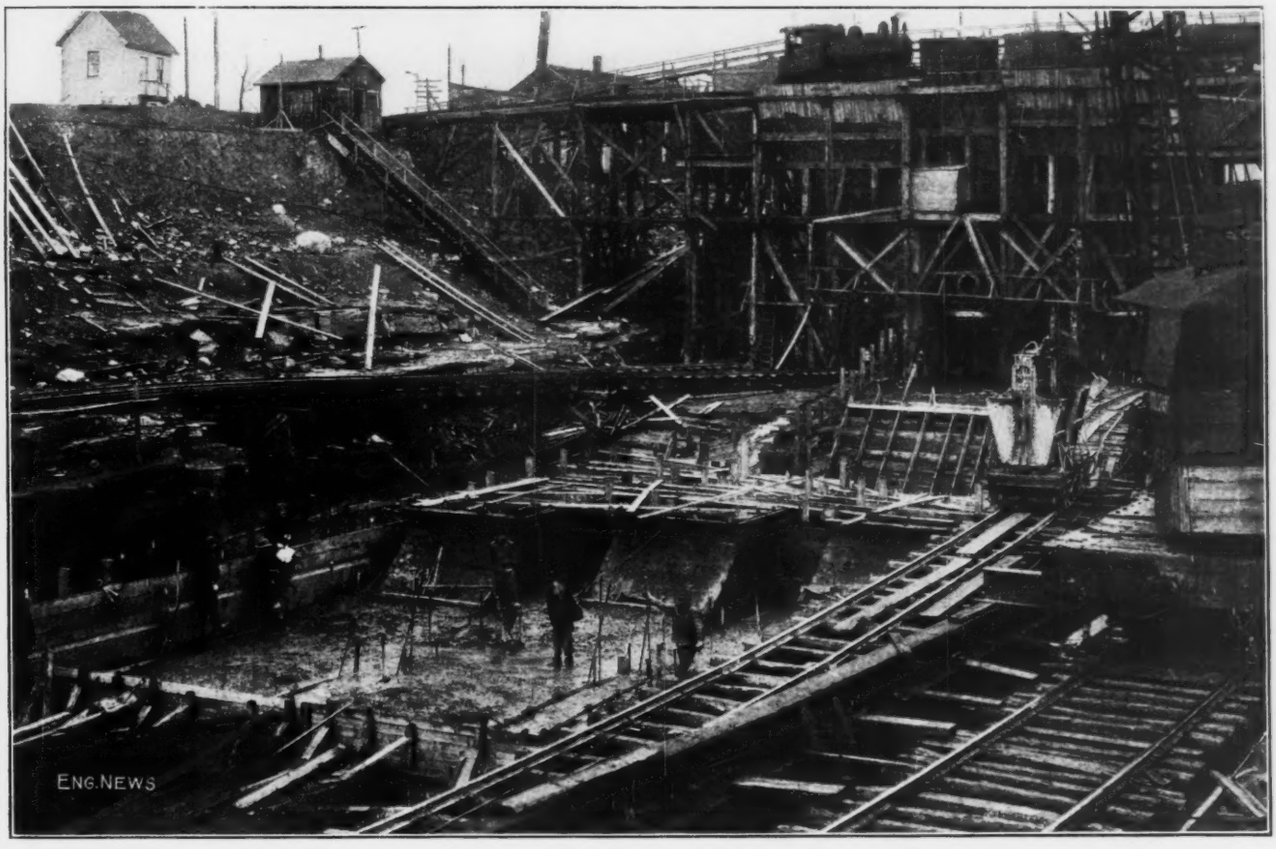


FIG. 1. CONCRETE MIXING PLANT FOR THE NEW LOCK CHAMBER, NEW LOCK AT SAULT STE. MARIE

two new locks (No. 3 and No. 4). The McArthur Bros. Co., of Chicago, has the contract for the new canal at the upper or west end, which will form the approach to these two locks. On an average about 1100 men are employed by the several contractors on the lock and canal construction now in progress. For the period June-October, 1913, the number of men on the different sections of the work was about as follows: lock masonry (lock No. 3), 350; east approach to locks, 80; west canal, 600 (200 on Section 1 and 400 on Section 2); excavation for lock No. 4, 120; total, 1150.

Concrete

An immense amount of concrete is required for the lock and its auxiliary works, and as these works extend over a considerable distance, the distribution of the concrete was a special problem.

The concrete mixture varies with the quality of the stone, which comes from different quarries. The stone is sampled and inspected, and the mixture varied as required by the mechanical analysis. Special attention is given to the proportioning, with the result that the cement averages only 1.15 bbl. per cu.yd. of concrete, although it runs as high as 1.50 bbl. in some cases for special work. The concrete for the canal walls is made with either crushed trap or limestone, screenings and sand. The stone for the concrete of the lock walls, however, is a mixture of about 66% trap rock and 33% gravel, with screenings and sand.

For ordinary concrete the aggregate is so combined as to give the smallest practicable volume of voids, and the mortar (usually 1 cement to 2½ sand) is used in sufficient quantity to give a slight excess over the voids in the aggregate. In some of the work, gravel is used that has too great a proportion of sand, and in that case the additional cement required is supplied at the expense of the contractor.

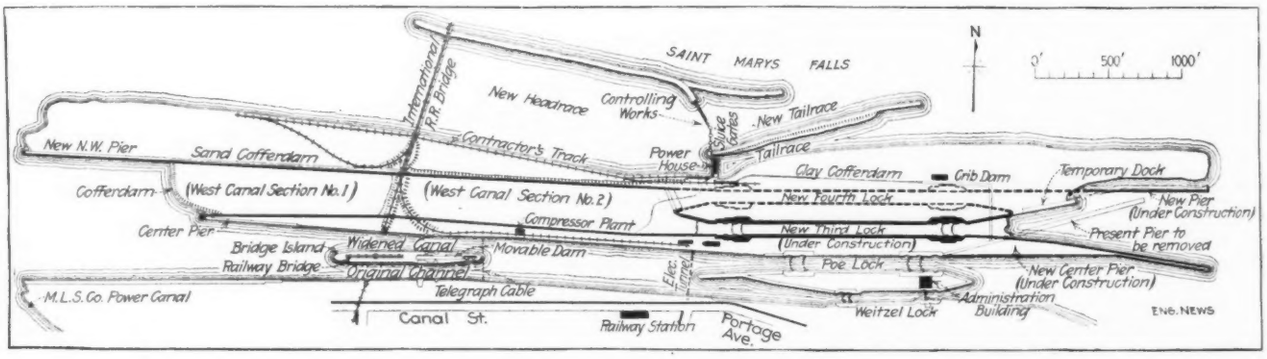


Fig. 2. Plan of Canals and Locks at Sault Ste. Marie, Mich.; Showing the Second Canal and the Third and Fourth Locks Now under Construction

Concreting Methods for Lock No. 3

The side walls of the lock are composed of monolithic concrete blocks 30 ft. long, 26 ft. wide on the base and 50 ft. high. They were built as alternate blocks, the intermediate blocks being built later, as shown in Figs. 3 and 4. About 175,000 cu.yd. of concrete are required for the new lock, exclusive of the canal walls and the approaches.

The concrete-mixing plant for the work on the lock chamber is located in the lower entrance. There are two 2-yd. mixers and one 1¼-yd. mixer (only two of which are used ordinarily), placed at such a height as to deliver the concrete by gravity to the distributing buckets on cars on the lock floor. Above the mixers are the cement, sand and stone bins, with a shed for the storage of about 1000 lb. of cement, and a gravity water tank. A narrow-gage track runs across the bins, the sand and stone being delivered by drop-bottom dump cars, while the cement is handled in sacks. This mixing plant is shown in Fig. 1, with a supply train standing over the row of bins, and a car with a concrete-depositing bucket standing near the locomotive crane at the right. A section of the floor and discharge culverts is being concreted, and the three slopes of concrete indicate where these culverts rise to the level of the floor of the lower entrance, after passing beneath the gates and sills.

For distributing the concrete from the mixers to the forms there are laid upon the floor of the lock two double-track narrow-gage industrial railways with loop ends. Each of these is operated by a continuous ¾-in. cable running at about 200 r.p.m. and driven from a drum with a 35-hp. motor. A typical arrangement of these tracks is shown in Fig. 3, the arrangement being modified as required by the varying positions of the forms and the work on either side of the lock. This plan shows also the general arrangement of the mixer plant and the contractor's yard, which is described below.

For handling the concrete, drop-bottom 2-yd. buckets are used, which are conveyed on four-wheel flat cars fitted with cable grips and having struts to support the sides of the bucket. As a car with an empty bucket comes around the loop and reaches the concrete plant, a man releases the grip and stops the car at the spout. As soon as it receives its charge, the grip is clutched to the cable and the car proceeds. When it reaches the point where concreting is being done, the grip is again released and the car stopped. A locomotive crane with a 70-ft. boom then picks up the bucket, hoists it, swings it around, lowers it into the form and dumps it, and then returns it to the car. The grip is again clutched to the cable and the car proceeds to the concrete-mixing plant with the empty bucket.

Fig. 4 shows this work in progress. Three of the steel forms for the face of the blocks (described later) are in place, and between them are completed blocks and spaces for the additional blocks. In front of the steel forms is a standard-gage track for the locomotive crane, and parallel with this is one of the cable railways, extend-

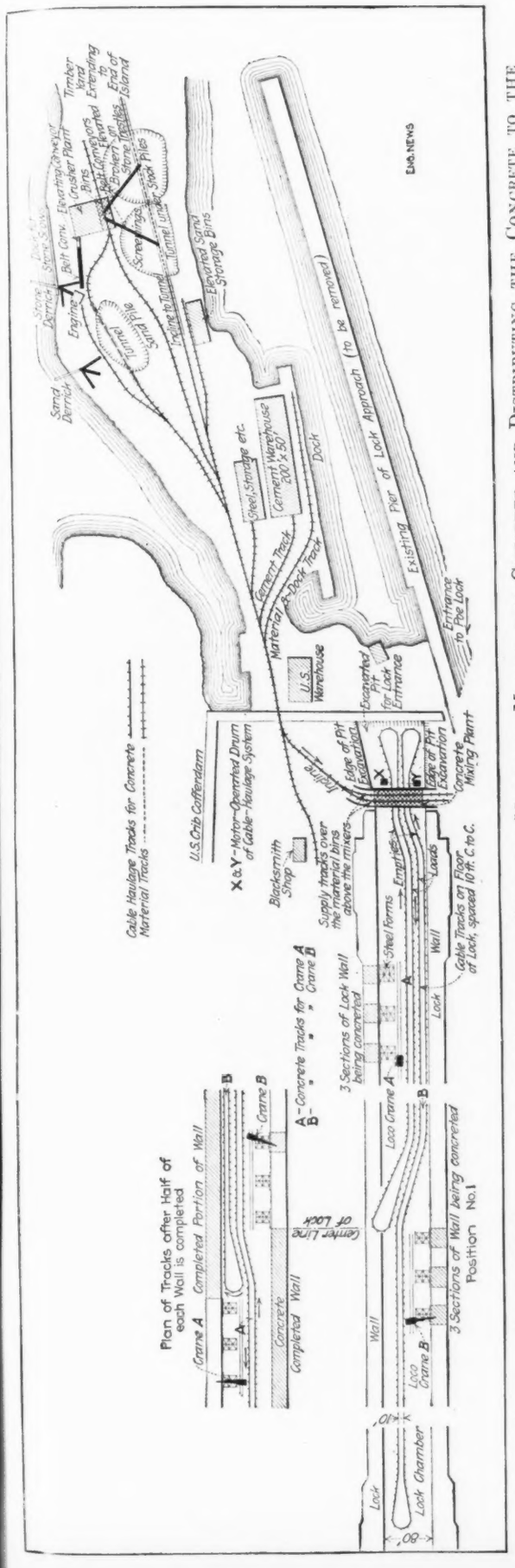


FIG. 3. PLAN OF CONTRACTOR'S PLANT FOR THE STORAGE OF CONCRETE MATERIAL, MIXING THE CONCRETE AND DISTRIBUTING THE CONCRETE TO THE WORK ON THE NEW LOCK CHAMBER AT SAULT STE. MARIE, MICH.

ing to its loop terminal at the right. On the cable tracks are the flat cars with the concreting buckets. This view is looking southwest toward the upper end of the lock, and the crane at the right stands on the level of the floor of the approach canal, while the other tracks are on the floor of the lock. Beyond the concrete blocks of the canal wall may be seen the pilot house and smokestack of a large steamer in the present canal.

At the lower end of the lock, where the walls were too wide to be reached by the derrick, a cableway of 250-ft. span across the lock and walls serves for handling the steel of the forms and other parts and for placing the concrete near the back of the walls. At the upper end of the lock, a separate mixer plant with a single 1-yd. mixer was installed to take care of small wall work at that end.

At the east end of the work, and east of the lock entrance, is the contractor's storage and repair yard, with shops, timber yard, stone-crushing and screening plant, stone and sand stockpiles and bins, cement warehouse, etc. Here the cribs for the approach piers are built and launched. The timber yard has a low trestle with a light derrick-car for handling the timbers. The layout of this storage and supply plant is shown in Fig. 3.

Gravel is dredged from the river about 12 miles above the canal. It is handled in large barges, having temporary sides built up to give increased capacity for the deck load, while at each end of the deck is a steel derrick handling a grab bucket. The buckets are used to dredge the material, and also to unload it at the hoppers on shore or the floating plant. Crushed stone is delivered in the same way, but a large proportion of the stone is delivered in quarry size by hopper scows. These dump it in water 22 ft. deep, to be recovered as required by a derrick and 2-yd. clam-shell bucket, the bucket delivering the stone to the bin of a crusher plant. This plant has two crushers, with screens, conveyors, etc.

Gravel delivered by barges is unloaded by grab or orange-peel buckets and delivered to the hopper of a belt conveyor which carries the material to the elevating conveyor of the revolving screens. The sized output is of two classes: stone of ¾- to 2¼-in. size, and screenings finer than 1 in. These are carried to the stockpiles by two inclined belt conveyors, discharging at a height of about 60 ft. from the ground. On one side of the yard the sand is delivered by the derrick scow to a row of elevated bins having side doors and spouts for loading the material cars by gravity. On the other side, sand is handled from deck scows to a stockpile over a loading tunnel.

A tunnel passes also under the other stockpiles, the stone and screenings being delivered to the cars by overhead traps and gates. Narrow-gage 5-yd. cars transport the materials to the bins above the mixer plant, the cars having bottom doors on each side for dumping from the track which is laid over the bins.

COLLAPSIBLE WOOD FORMS FOR THE CULVERTS

There are six filling culverts beneath the floor of the lock (only four of which extend the full length), and these are built on the surface of the rock excavation, the floor of the lock forming their roof. Fig. 5 shows the forms being placed for the four filling culverts which extend the full length. In the foreground are the forms for three of the six emptying culverts, which pass beneath the lower gates and sills and then rise to horizontal discharge openings level with the floor of lower entrance

to the lock. These openings are shown, but are partly covered by loose planks. The vertical rods are let into the solid rock and form anchorage attachments for the steel reinforcement of the lock floor, which is thus anchored against upward pressure.

Wood forms are used for the culverts, having frames 2½ ft. apart, covered with 2x8-in. tongued-and-grooved plank lagging for the flat portions and narrower oak strips for the curved corners. Each frame consists of four ribs, braced by interior struts, 6x6 in. Each rib is composed of two planks 3x10 in., and wedges are fitted to adjust the ribs at each corner. When the concrete has set, the struts are removed, and the wedges are knocked out, allowing the ribs to slide inward. The form thus collapsed clears the concrete by 6 in. at top and bottom and 3 in. at the sides. The entire 30-ft. length of the form section can then be pulled ahead and again expanded. The construction of these collapsible wood forms is shown in Fig. 6.

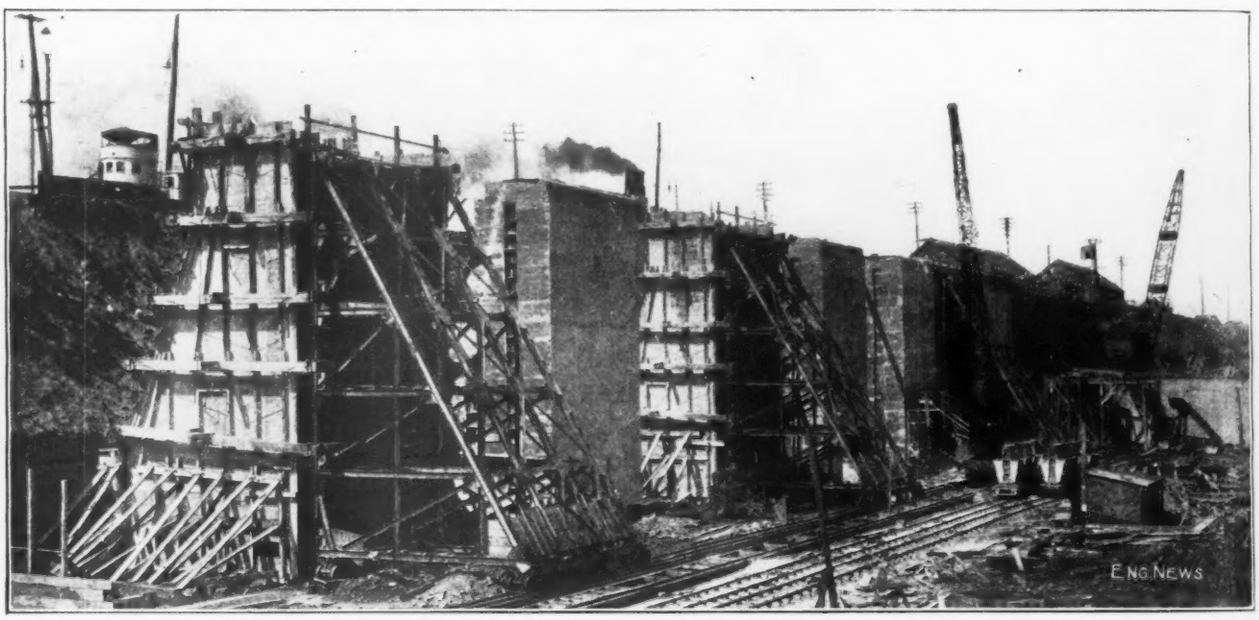


FIG. 4. BUILDING THE WALLS OF THE NEW LOCK AT SAULT STE. MARIE, MICH.

(This shows the steel forms for the face of the wall blocks, with completed blocks between them. At the right are the drop-bottom concrete buckets placed on the cars of a double-track narrow-gage cable haulage railway. Between this railway and the steel forms is a standard-gage track for the locomotive crane which handles the buckets and deposits the concrete in the forms.

STEEL FORMS FOR THE LOCK WALLS

The steel forms for the inner faces of the lock walls are an interesting feature of the work, owing to their design and their size. They have a height of about 50 ft. over all and are made in lengths of 30 ft., that being the length of the blocks or sections of the wall. There are six sets of these forms, three for each wall, as shown in Figs. 3 and 4. They were built for the Great Lakes Dredge & Dock Co., by the Kenwood Bridge Co., of Chicago, and the design is shown in Fig. 7.

Each complete form consists of four structural-steel triangular trusses 45 ft. high and 25 ft. base, resting on two sills and connected by diagonal bracing. Each sill is mounted on two four-wheel trucks having 18-in. wheels. These run on two tracks of 20-in. gage, spaced 22 ft. 9 in. c. to c. When in position, the thrust (due to pressure of concrete) at the bottom is taken by inclined timber struts having one end fitted to a pocket in the concrete floor and the other end brought to a bearing against the sill by means of a jack screw. A vertical jack screw under the rear of the frame provides for leveling the form and setting the face plumb. The posts and sills are pairs of 8-in. channels with batten plates across the flanges. The horizontal members are of similar construction but with 7-in. channels. The diagonals and vertical struts are pairs of angles.

The faceplate is independent of the framing of the form, and consists of ¼-in. plates riveted to a framing of channels and angles forming panels 4 ft. square. This frame has also four vertical 12-in. I-beams which carry the screws used in adjusting the faceplate to position and in taking the thrust of the concrete against the faceplate. These screws are of 2½-in. cold-rolled steel, moving in heavy nuts and having the front end pointed to fit a socket carried by the I-beam. The nuts have four socket arms with holes for 1-in. crowbars or capstan bars. To prevent buckling of the face, the I-beams are backed at intervals by capstan head jack-screws, which are run out to bear against the rear flanges of the I-beams after the face has been adjusted to position. Some of these details are shown in Fig. 8.

The top of the face of the wall has a slight inward batter, ending with a curve to the horizontal surface. For this part of the wall, the form has a separate faceplate. The lower end of this rests on a shelf angle on the main face plate, 3-in. oak filler blocks being interposed to allow of leveling up the top edge, in the event of any settling of the main part of the form. The upper projecting end is secured to the vertical posts of the framing by rods, which act as struts when the concrete is placed.

Fig. 9 is an interesting diagram of concrete pressure against the face of steel form. The concrete in the lower part of the form having set before that at the upper part is deposited, the conditions are not those of fluid

pressure throughout. The diagram is based on concrete deposited at the rate of 40 cu.yd. per hour, with the initial set of the cement at 4½ hours and the final set at 7 hours. The maximum unit pressures shown are assumed as 10 ft. of liquid weighing 100 lb. per cu.ft.

The sides and rear of the forms are of timber construction, and timber trusses on the rear are employed to give the necessary resistance to the pressure. Fig. 10 shows a view of this timber construction.

The New Canal for Locks Nos. 3 and 4

It will be seen by the plan, Fig. 2, that the two new locks will be served by a canal parallel with the present canal, the axes of the two locks being 120 ft. apart. That portion of the canal wall built in the wet will have rock-filled timber cribs capped with concrete walls extending to 1 ft. below water level; the cribs will be back-filled with loose rock.

The canal will be 8100 ft. long, about 300 ft. wide, and carrying 25 ft. of water between walls 30 ft. high. Where the work could be done in the dry, the rock face was cut with channelers, and a concrete wall was built on top of the rock. The sides are practically plumb and smooth. The concrete is carried to the full depth where the rock face does not stand well, so that this wall is from 7 to 30 ft. high. Even where the rock does stand there are occasional seams and holes in the lower portion, and these are filled with concrete patching. To secure the concrete in place, horizontal holes are drilled in the rock for steel rods whose ends project into the space to be concreted. The upper end of the cut is closed by a rock-fill coffer-dam.

The excavation is mainly in red Potsdam sandstone with grey streaks. A part of the rock is seamy and soft, while other parts are sound and hard, making a good foundation. A considerable amount of water was encountered, necessitating continual pumping.

Along the sides of the canal, next to the channeler cuts, the rock was taken out in two lifts. In the body of the cut, however, the excavation was sometimes made in a single lift. This was made practicable by the use of deep-hole drills, which put down blast holes 4 in. in diameter to a depth of 14 to 27 ft., at intervals of about 8 to 10 ft. Each hole received a charge of 45 lb. of 60% dynamite, and the rock was so shattered that it was handled by steam shovels. The largest blast was made with 4650 lb. of dynamite to 100 holes.

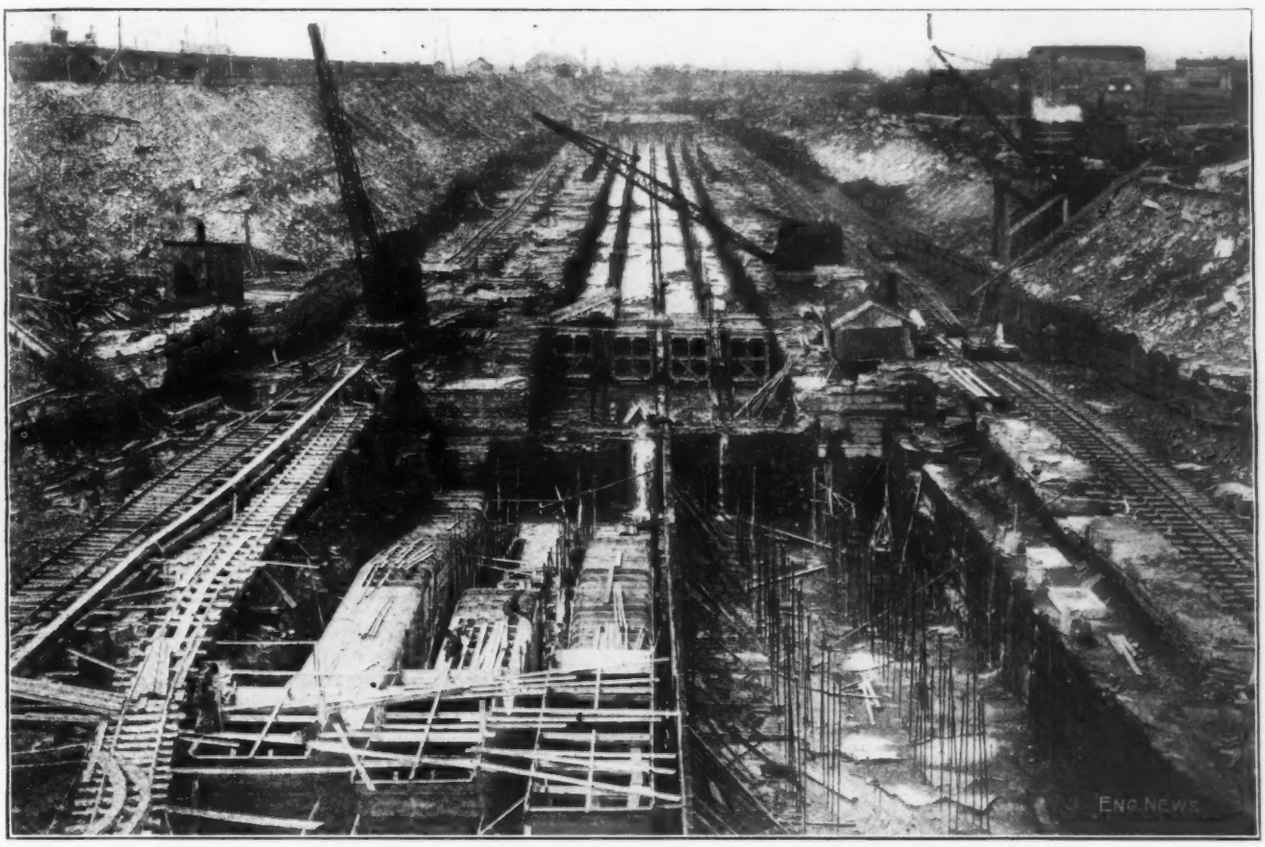


Fig. 5. Concreting the Culverts in the Floor of the Lock

(The four culverts in the rear are for filling the lock. In the foreground are three of the six emptying culverts. The view is looking west from the lower end of the lock.)

At first a 400-ft. cableway was used to handle skips, but as most of the material had to be dumped beyond reach of the cableway, the skips had to be deposited on cars. The economical advantages of the cableway system apply particularly where the material can be dumped direct, as in building a levee or spoil bank parallel with the cut, and within the reach of the cableway.

Under the conditions of this canal, the results were not satisfactory and the cableway was abandoned. The material is now loaded by the steam shovels directly into side-dump cars hauled by contractor's locomotives. Both standard and narrow-gage equipment is used, the cars being of 12- and 4-yd. capacity, respectively. The steam

shovels were mainly 70-ton machines with 2½-yd. buckets, and the material was hauled from 2000 to 8000 ft. The concrete mixing plant consisted of two 1¼-yd. mixers, and the concrete was hauled to the work in 1½-yd. buckets or cars. Four buckets were placed on each car,

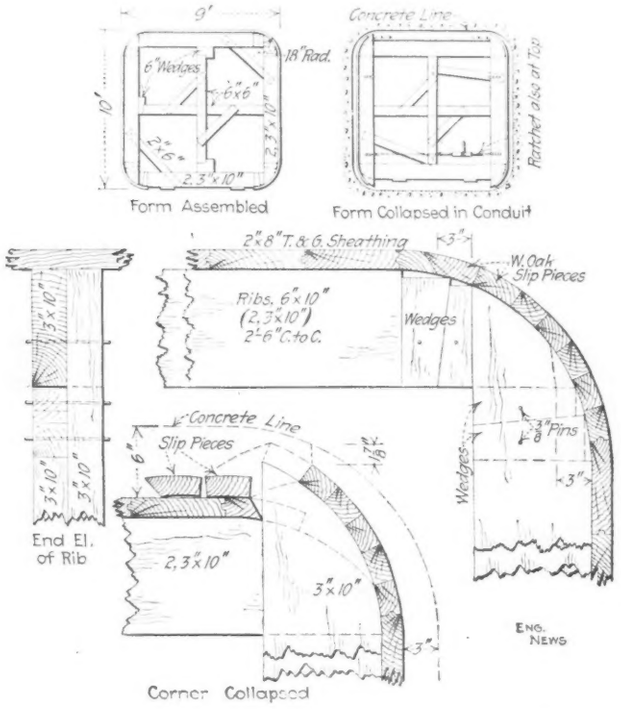


FIG. 6. COLLAPSIBLE WOOD FORMS FOR THE FILLING CULVERTS OF THE LOCK

and three concreting trains are in service. During the past season, the contractors have employed about 700 men on this canal construction.

For the excavation of the lock pit of lock No. 4, the contractor's plant consists of a steam shovel, two traction drills, two channelers, and three standard-gage trains of seven cars each.

LOWER APPROACH TO THE NEW LOCKS

It will be seen by the plan (Fig. 2) that the approach to the lower end of the new locks will include a long pier separating it from the approach to the present locks. This is now under construction, and necessitates the removal of part of the existing pier.

Near its outer end this new pier consists of a row of 30-ft. timber cribs, while near the locks it is built of two rows of cribs. The cribs are filled with stone, and where there are two rows, stone filling is placed between them. Each line of cribs is surmounted with a concrete wall, the walls being built in alternate blocks about 28 ft. long. For this work the contractor has a floating concreting plant, with mixer and material bins mounted on a barge; which also carries a derrick for operating a grab bucket or handling concrete buckets. There is also an elevator tower, the bucket of which receives the concrete direct from the mixer and discharges it into the hopper top of a pipe or chute which has a vertical length at the discharge end.

Derrick scows deliver material to the hoppers on the barge. The concrete for this pier is made with gravel instead of crushed stone.

POWER PLANT AND CONTROLLING WORKS

A power plant at the side of the river, built originally by a private company, has been acquired by the government and is now leased to the company. Current for operating the gates of the new locks will be supplied by this plant. At present it supplies current for lighting the locks and canal. The plant consists of three vertical-shaft turbines, each driving a generator of 250 kw. The normal head on the wheels is from 14 to 17 ft. The operation of the locks requires only a small part of the power developed.

The head-race of the power plant is part of a controlling system for regulating the height of water in the river

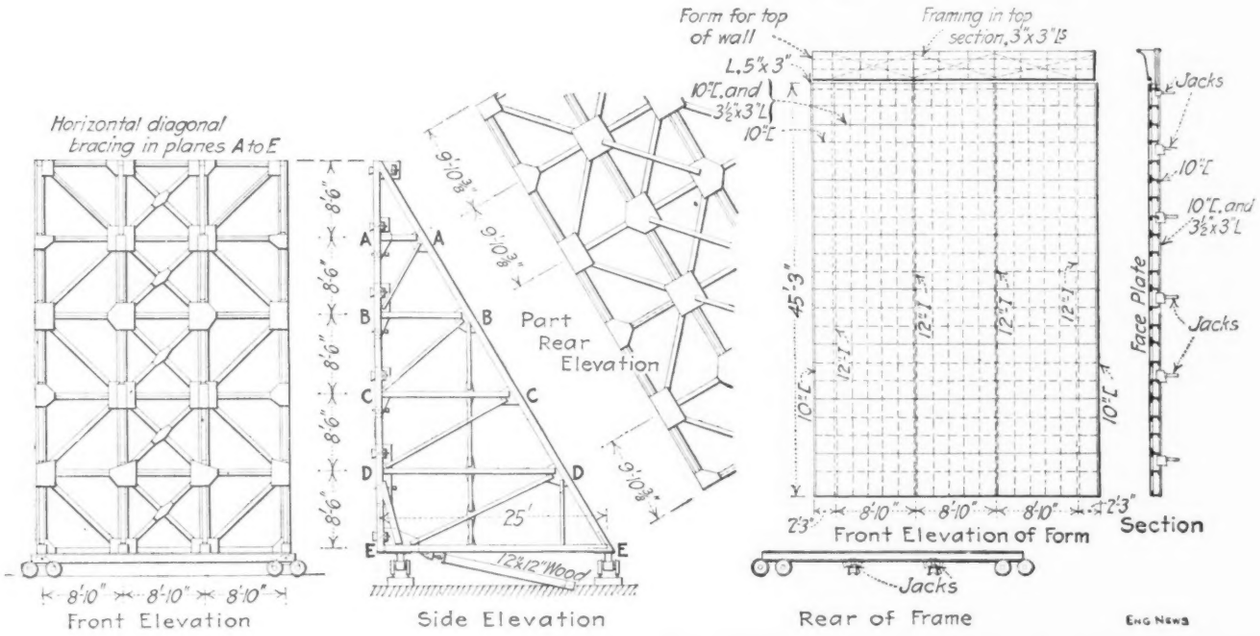


FIG. 7. STEEL FORMS FOR THE FACE OF THE BLOCKS FORMING THE LOCK WALL

above the canal, and consequently the level of Lake Superior. The outer side of the head-race channel is formed by a rock-fill dike, and the lower end is closed by a dam and the power house. Adjacent to the power house are three Stoney sluice gates 15x33 ft., with the sills of the gate openings at elevation 102. The gates

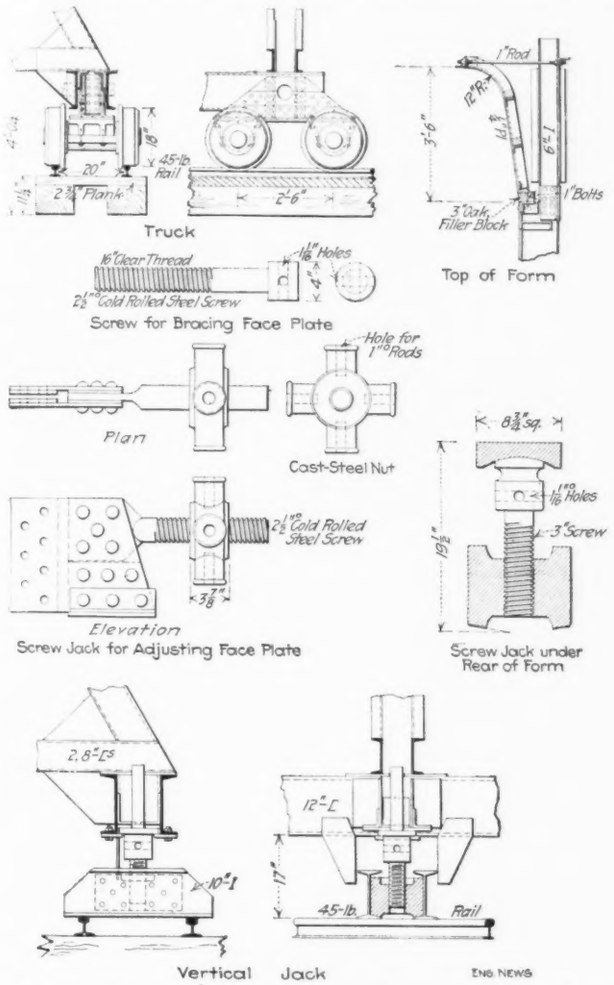


FIG. 8. DETAILS OF THE STEEL FORMS FOR THE LOCK WALLS

A, truck. B, jack for adjusting the faceplate of the form. C, screw for bracing the faceplate. D, separate faceplate for top of wall. E, jack at rear of form for plumbing the face.

are operated by hand through a train of gears. To prevent them from being rendered inoperative by being frozen to the seats in cold weather, there is a chamber around the edge of each gate, into which steam can be discharged from a hose connection. Beyond the sluice gates are two ice passages with openings 16 ft. wide, closed by stop logs with sill at elevation 112.

The dam, which adjoins the dike, has an overflow section or spillway 150 ft. long, with its crest at elevation 117.

The diversion of water from the river above the ship canal by means of two power canals (one on each side of the river) has an important influence on the water level, and in order to prevent the water from being drawn down too low at times of low stages in Lake Superior, the Canadian power company built regulating works in the shallow water on that side of the river, a weir or overflow dam reducing the flow at low-water stages.

On the American side, the Michigan Lake Superior Power Co. (formerly affiliated with the Canadian company) has a large canal and water-power plant. It is permitted to draw a supply of about 10,000 cu.ft. per sec. at present. Under the terms of its permit the company must reduce its flow in the event of low water in Lake Superior. The company desires to enlarge its plant and to get permission to increase its supply of water to the canal. This will probably necessitate the construction of compensating and regulating works on the American side, extending from the dike of the power headrace across at least a part of the deep-water channel of the rapids.

MISCELLANEOUS

BRIDGE—The Canadian Pacific Ry. bridge over the river at this point crosses the present canal by a double-arm swing bridge, the pivot pier being on an island in the canal. The new canal, however, will be spanned by a Strauss double-leaf bascule bridge having a span of 336 ft. between trunnions. A special feature in the design of this bridge is the use of center locks in the chords which will so connect the two leaves as to convert the closed span into a single truss.

PONTOON CRANE—For handling the lock gates when it is necessary to remove or replace them, there is a gate-lifting pontoon, carrying A-frames with a hoist of 200 tons capacity, which can be increased by utilizing the buoyancy of the pontoon by means of water-tight compartments in the hull.

REPAIR WORK—Much of the repair work on the present canal has to be done in winter, when navigation has ceased. This includes concreting, but long experience

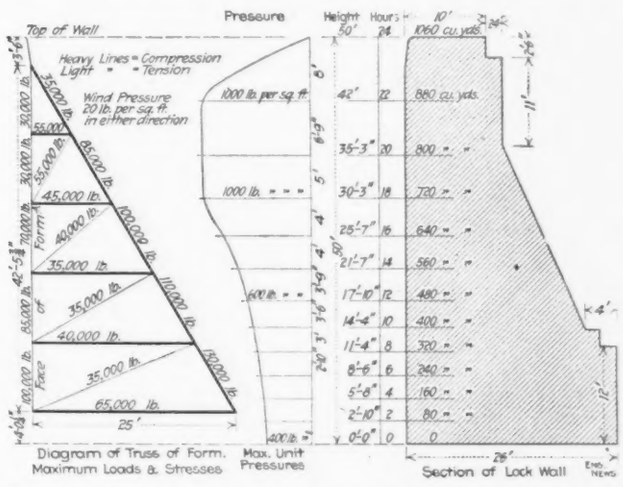


FIG. 9. DIAGRAM OF PRESSURE OF CONCRETE AGAINST FACE OF FORM WHILE THE WALL IS BEING BUILT

(The concrete at the base will have set while that near the top is fluid.)

has developed methods of getting satisfactory results even in very cold weather. For building that portion of the canal wall which extends below the water level, the form is lined with canvas, which protects the concrete from the effects of wash.

CONCRETE POLES—Concrete poles for electric lighting are being used at the canal and locks. These are made in the winter, in order to provide work and keep the force together. They cost about $40 each.

Traffic at "The Soo"

A remarkable feature of the navigation at "The Soo" is the rapid and enormous increase of the traffic of this waterway, which is used by about 70% of the total traffic on the Great Lakes. This increase (including both the American and the Canadian canals) has averaged about 20% per annum, and the annual traffic has grown from a minimum of 14,503 tons of freight in 1855 to a maximum of 72,472,676 tons in 1912. The growth by decades has been as follows (as given in the annual statistical report of operation, 1912):

Decade	Average annual increase	Total traffic 1 = 1000 tons
1855-64	44%	1,203
1865-74	12%	4,829
1875-84	17%	14,869
1885-94	17%	80,343
1895-04	12%	253,003
1905-12 (8 yrs.)	....	441,838

During 1912 (with a navigation season of about 240 days), the total number of vessels passed was 22,778, aggregating 56,736,807 registered tonnage. The American canal carried about 65% of the number and a little more than 50% of the vessel tonnage. The average number of vessels per day was 39 through the Poe lock, 27 at the Weitzel lock and 33 at the Canadian lock, or a total of 95. The time consumed in passing through the canal and lock on the American side (including the time of waiting to enter the lock) averaged about two hours.

The maximum freight traffic for one day was on Aug. 26, 1907, when 187,649 tons of freight were carried by 121 vessels aggregating 287,385 registered tonnage. The total tonnage of freight carried in 1912 (72,472,676 short tons) was valued at $791,357,800, distributed as shown in the accompanying table. This table shows also that iron ore and coal represented respectively about 64% and 20% of the tonnage. American vessels carried 94% of the total freight and 32% of the passengers. The table shows also the distribution of the freight as to the direction and the use of the two canals. The amounts given are in short tons.

TRAFFIC AT THE "SOO" CANALS: 1912

	Quantity	P.c. of total value
Grain and flour	7,588,202 tons	33.17
Merchandise	1,765,480 tons	31.62
Iron ore	46,303,423 tons	16.97
Iron (pig and mfrd.)	654,892 tons	6.41
Coal	14,931,594 tons	6.23
Copper (refined and concentrates)	116,954 tons	3.62
Lumber	667,542 M. ft. b.m.	1.98

Freight	American Canal 1000 tons	Canadian Canal 1000 tons	Total 1000 tons
Eastbound	19,631	35,747	55,378
Westbound	13,194	3,901	17,095
Total freight	32,825	39,648	72,473

It is of interest to note the growth in size of vessels. The first freight carriers of over 500 ft. and over 600 ft. in length appeared in 1904 and 1907 respectively. Of 853 freight steamers in 1912, there were 106 up to 200 ft. in length, 359 of 200 to 400 ft., 159 up to 500, 127 up to 600 and 12 over 600 ft. The greatest length of any lake vessel is 617 ft., and the greatest width of beam 64 ft. The greatest tonnage of freight is iron ore, and its largest single cargo in 1912 was 13,511 tons, but the highest record is a cargo of 13,978 tons in 1908. On the other hand, the vessel carrying this cargo in 1912 made the record for the greatest amount of freight and the greatest ton-mileage for any one season, the amounts being 374,014 tons and 327,738,366 ton-miles.

Removing and Washing Sand from Sewage Grit Chamber, New Bedford, Mass.

By Walter N. Charles*

A general description of the new sewage-disposal system for the City of New Bedford, with its pumping and screening stations, was given in Engineering News, of July 31, 1913. As was there stated, the sewage is discharged through a submerged outfall conduit 3300 ft. in

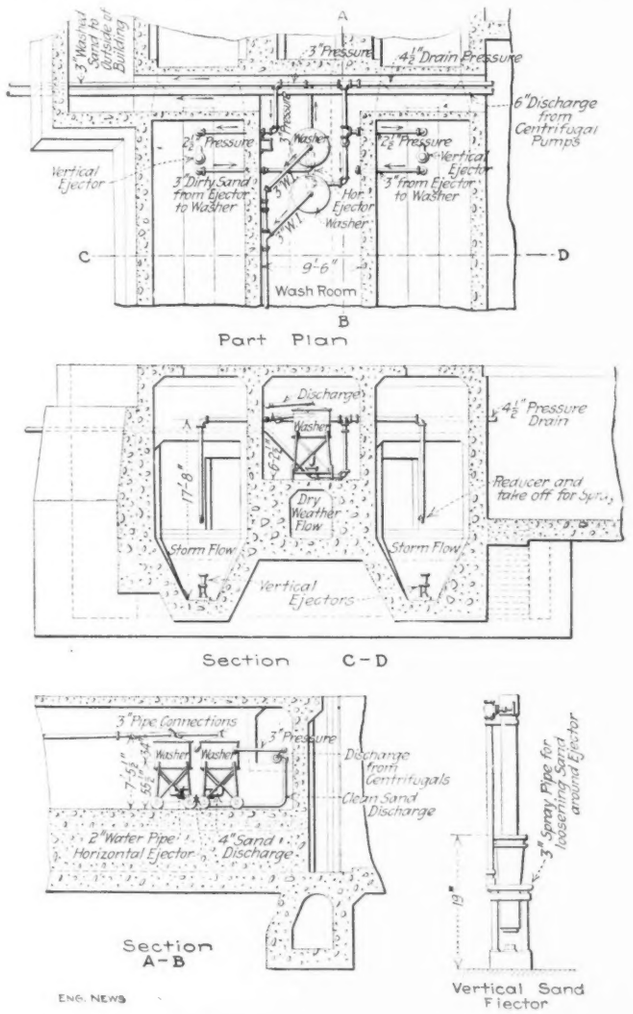


Fig. 1. Sand-Washing Apparatus for Grit Chambers, New Bedford Sewage-Disposal Plant

length into Buzzards Bay. As the sewers of the city are mostly on the combined system, taking both house sewage and storm water, there is at times a considerable amount of sand carried into the main intercepting sewer. To prevent this sand from collecting in the outfall conduit, where its removal would be practically impossible, a screen and grit chamber has been built near the end of the land section of the sewer. This station is near a residential district and the dumping of polluted sand taken from the sewage would be very objectionable. To avoid this, sand washers are being installed which will receive the sand from the settling basins which form the grit chamber.

*Assistant Engineer, Intercepting Sewer System, New Bedford, Mass.

cleanse it, and allow it to be ejected onto the beach, or for filling in the vicinity, in a state as little polluted as when it entered the sewers.

The settling basins [or enlarged storm-flow channels. —Ed.] in the station are in duplicate (see Fig. 1) so that one may be cleaned while the other is in use. Neither will be in use except in wet weather, the sewage passing through a separate channel (Fig. 1) in dry weather. The sewage will be screened in any case to eliminate sticks, rags and other solid matter.

In the bottom of each of the settling basins, a vertical sand ejector is being installed, as shown in the general plan and sections and in the detail drawing and pen sketch which together make up Fig. 1. When the basin is to be cleaned, the gates at either end are closed and the liquid drawn off through pipes suitably provided. The sand in the bottom is then pushed to the ejector by men and, after considerable agitation, settles to the bottom. Meanwhile, the dirty water passes out through a 3-in. vertical pipe in the top of the tank and is led back into the sewer beyond the station. The cleaned sand is drawn off at the bottom of the washer tank through a 4-in. opening and drops into a hopper in the bottom of which is a horizontal ejector (Figs. 2 to 5) which drives the sand out through a 3-in. pipe to the beach or to any destination desired. This ejector was supplied by E. M. Nichols, of Philadelphia.

An attempt will be made to operate the ejectors and sand washers continuously during storm flows and thus take up the sand as fast as it settles. If this could be accomplished and the settling basin kept clean to any reasonable degree, the operation of the station would be much more convenient and probably less expensive. For this experiment baffle plates will probably be used over

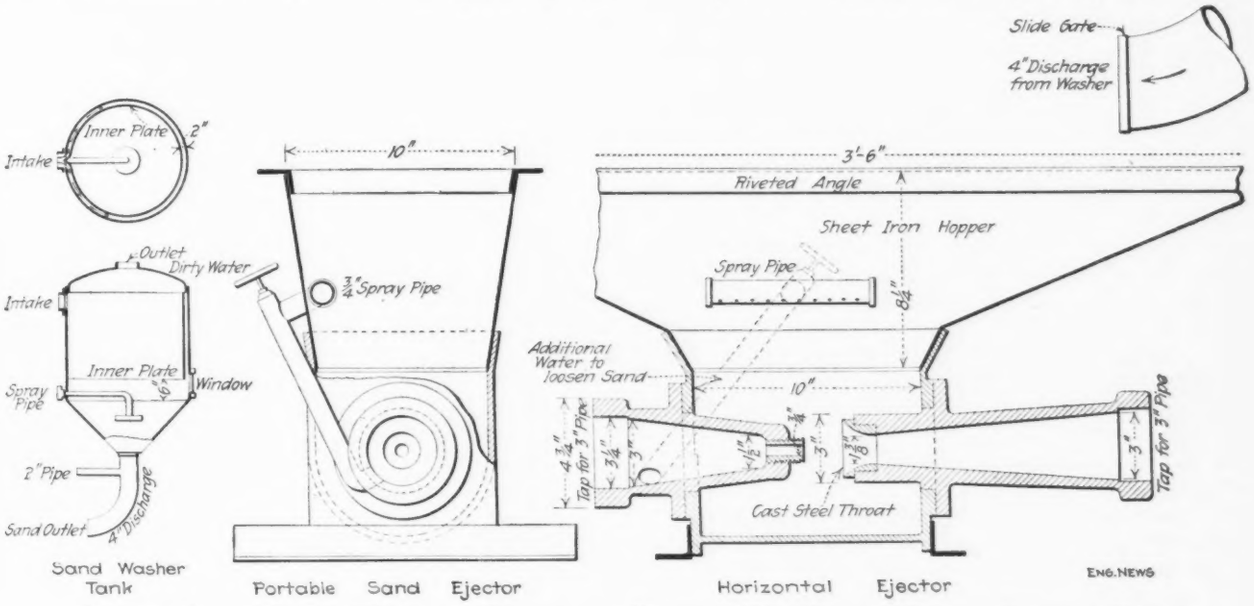


FIG. 2. SAND WASHER TANK AND HORIZONTAL EJECTOR, NEW BEDFORD SEWAGE-DISPOSAL WORKS

using a hose stream or shovels. The ejector sucks up the sand by a powerful stream of water and delivers it to the sand washers in the room above the dry-weather channel, a rise of about 17 ft.

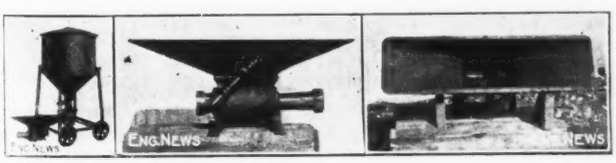


Fig. 3. Tank and Horizontal Ejector. Fig. 4. Hopper and Ejector Upright. Fig. 5. Ejector on Side.

VIEWS OF SAND-WASHER TANK AND HORIZONTAL EJECTOR FOR REMOVING WASHED SAND

The sand washers are in duplicate (Fig. 1) and are cylindrical steel tanks (Figs. 2 and 3) 3 ft. 8 in. in diameter, with conical bottoms, having a total height of 4 ft. 6 in. The delivery pipes, 3 in. in diameter, enter the tanks near the top. These pipes are fitted with flexible hose and couplings so that they may be connected to either tank. The sand coming to the washer tank has been mixed with a large amount of clean water (90% or more) at the nozzle of the ejector in the settling basin the vertical ejectors to throw down the sand as nearly as possible in the location desired.

The ejectors are constructed as shown in the sketches and derive their power from a stream of water with a nozzle pressure of about 100 lb. per sq.in. The nozzle is ¾ in. in diameter.

The washer tanks have a small window (Fig. 2) in the side so that the operator can see to what height the sand has settled. The sand washing may go on continuously and the sand be drawn off slowly as it accumulates. To aid the movement of the sand discharge, when necessary, a stream of water can be run through the 2-in. pipe shown connected to the 4-in. sand outlet (Fig. 2). All the pipes connected to the washers are provided with either valves or shear gates to control the flow.

Two 6-in. centrifugal pumps which are being installed in the station for pumping out the settling basins will have connections with the sand washers so that an alternative means of handling the sand will be available if necessary; but ordinarily these pumps will be used for pumping liquid only.

The two sand washers and three ejectors with all the piping will cost approximately $2000 installed.

The total cost of the station will be close to $80,000, as follows: Substructure, $27,000; superstructure, $32,000; machinery, $20,000 or more.

William F. Williams, consulting engineer, is in charge of the sewage-disposal system for the city.

Needed Improvements in the Water-Works System of Chicago

By William D. Barber*

The gradual growth of the water-supply system of Chicago has resulted in uneconomical and undesirable conditions in many respects, so that radical changes are needed to give the city a system adapted to its requirements. The accompanying cut shows the distribution system, and illustrates some of the points discussed below.

Three important points to be considered in connection with the improvement of the water-works system are as follows: (1) new intake tunnels, with cribs located so far from shore as to be beyond the range of roiled and polluted water, and taking their supply from near the bottom of the lake; (2) a rearrangement of the distribution system, dividing the city into districts of 50,000,000-gal. daily supply, with a pumping station in the economic center of each district; (3) a system of gravity tunnels from the intake tunnels to the several pumping stations, thus eliminating the present costly system of large force mains extending from pumping stations along the shore line. The new Springfield Ave., Central Park Ave., and Roseland stations are served by gravity tunnels, as shown.

Quality and Consumption of Water

The total registered pumpage of the Chicago water-works in 1912 was 201,784,810,000 gal. This represents more than the actual amount drawn from the lake as two of the 15 pumping stations of the Chicago system are booster stations; that is, they draw their supply from the mains, to increase the pressure in the highest portions of the city. By allowing a slip of 15% in the plunger displacement of the pumps and making the further deductions for the booster stations, the amount of water drawn from the lakes is 170,986,000,000 gal.

The present pumping stations now in operation, with their normal capacities per 24 hr., are as follows:

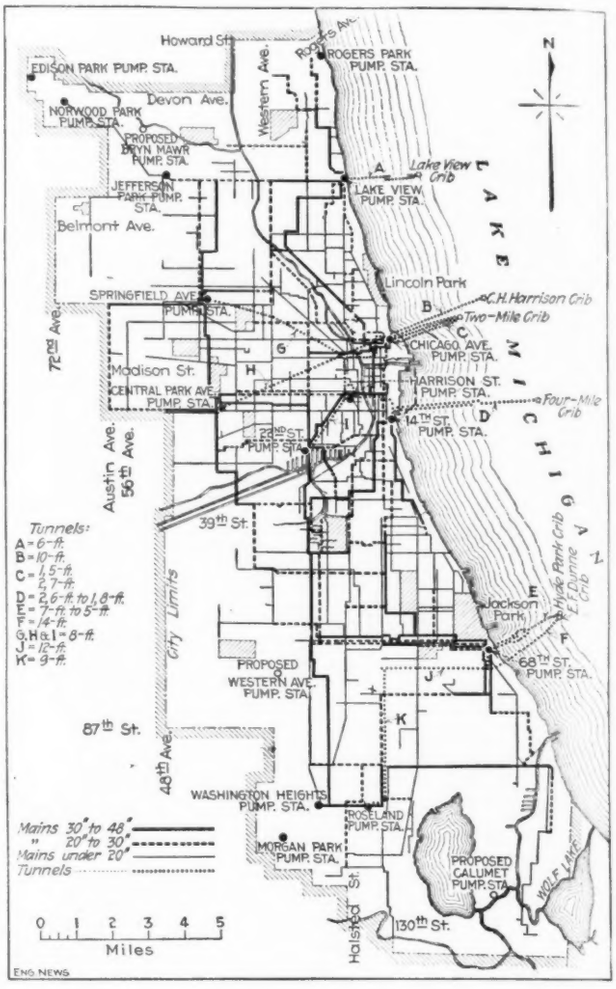
CAPACITY OF PUMPING STATIONS, CHICAGO WATER-WORKS

	Million gal.		Million gal.
Lake View	100	Washington Heights*	4.5
Chicago Ave.	99	Rogers Park	3
Springfield Ave.	100	Jefferson Park*	3
Central Park Ave.	100	Norwood Park	1.05
22d St.	110	Edison Park	0.076
Harrison St.	50	Morgan Park	1
14th St.	75		
68th St.	94	Total	790.626
Roseland	50		

*Booster stations.

In November, 1913, a very heavy storm on Lake Michigan caused a great amount of damage in the vicinity of Chicago. The filling for the new additions to Lincoln Park and the lake shore drive made by dumping street sweepings, earth, etc., was washed away to such an extent that the damage is estimated at over $500,000. The waves churned up this material and the undertow (always strong during storms from the east and northeast) carried this roiled water out beyond the intake cribs so that it was drawn through the ports and into the water tunnels to be supplied to the inhabitants of the city.

Such a condition should not be allowed, as clear pure water may be secured at all times by placing the intake cribs out beyond this roiled-water range, in deep water that is not affected by storms. There is no reason why the city of Chicago could not tunnel 10 or 15 miles under the lake for this purpose.



Map Showing the Intake Tunnels, Pumping Stations and Distribution System of the Chicago Water-Works

(Three of the new inland pumping stations are served by gravity tunnels.)

Another great defect in the Chicago water system is that the intake ports of the cribs are so constructed that the water is drawn directly from the surface rather than from the bottom of the lake. This causes the supply to be much warmer during the summer and also makes such conditions at the cribs in winter as to require constant watching to keep anchor ice from forming in the ports and gates that might shut off the city's water-supply entirely. All these conditions could be eliminated by locating the cribs in the deep-water zones and designing the intake ports in the proper manner, as suggested by the writer in an article in Engineering News, of June 19, 1913.

*Assistant Engineer, Bureau of Engineering, Department of Public Works, Chicago.

There are a number of points connected with the Chicago water system that need careful consideration at this time before the city makes further improvements or additions to this system. These points are the intake cribs, the tunnels, the pumping stations, and the distributing mains.

In the first place, observation tests and water analyses should be made of the lake so as to determine the direction and extent of the different lake currents, undertow and effects of storms and waves on the purity of the water. It will be found that at a depth of 50 to 70 ft. a body of pure water will be encountered which would not need treatment of any kind.

New Intake System

All the existing cribs are too near the shore. The Four-Mile Crib has the deepest water, but this crib furnishes its supply of roiled water and at certain times a large supply of other impurities taken in by the current, as this is within range of the dumping ground of scows that carry Chicago's filth out into the lake. As the cribs and tunnels are permanent improvements constructed to last for long periods without repairs and expense, the question of first cost alone should not debar the securing of the purest water in the lake for the city's needs.

The first great problem that confronts the city is the relocation of all the cribs and the extension of the present tunnels to the new cribs. When the proper sites have been determined, the methods employed in drawing water into the cribs should be very carefully considered, as suggested in the article already mentioned. Special attention should be given to drawing the water from a point near the bottom instead of at the surface.

In constructing any crib, the most practical and economical size of tunnel should be carefully considered. A tunnel of about 12-ft. circular diameter appears to be the maximum for safety in construction. Such a tunnel, with a flow of velocity of 3 ft. per sec., will carry 220,000,000 gal. per 24 hr. with a loss of about 0.1 ft. in friction head per 1000 ft. of tunnel. This will give an economical size for crib capacity.

The 12-ft. tunnel may be run from the crib to an economical distributing point in the city, and by means of properly located sluice gates and branches supply four pumping stations of 50,000,000 to 60,000,000 gal. capacity each, situated in the center of water demand of its districts. The operating cost to the city would be simply the maintenance of crib, pumping stations and distributing mains, plus the cost of pumping.

New Locations for Pumping Stations

The next step is the location of the pumping stations. A glance at the accompanying map showing the location of the present 15 stations shows that the city has never been divided up into definite districts with stations economically situated so as to care for these districts. Such a districting should be planned, and as the city grows new districts should be provided as independent additional units of the city's water-supply.

A study for such districting will show that all the stations situated along the lake shore would finally have to be abandoned and new stations built, centrally located for the several districts. These shore stations are the Rogers Park, Lake View, Chicago Ave., 14th St. and 68th St. stations. These have to force their water all in one direction, thus greatly lengthening their distributing mains and increasing the cost of operation, maintenance and repairs. These stations can supply the district north, west and south of them for a distance of two or three miles (with the one exception of Rogers Park), without lack of pressure. To increase their capacity simply means the pumping of this extra supply of water through miles of pipes before it can be placed at the point required. This results in great expense for extra piping which should not be necessary. It also involves needless expenditure of power to force the water this long distance when the water might flow by gravity through tunnels.

The proper location of these stations would mean shortening by half the lengths of the present large distributing mains now called for, with much smaller mains in general and with great changes and alterations in the smaller mains.

Gravity Tunnels vs. Force Mains

The system of parallel or duplicate mains shown on the map of the distributing system is evidently irrational. It costs from $15 to $20 per ft. to lay a 48-in. cast-iron pipe (in earth) along the streets of Chicago, not counting the additional cost of maintenance for a term of years. The cost of building an 8-ft. tunnel (through earth) is also from $15 to $20 per ft., but the tunnel will carry at the same velocity more than four times as much water as the pipe. Using a velocity of 3 ft. per sec., the tunnel will carry 100,000,000 gal. as compared with 24,000,000 gal. for the pipe. The water in the tunnel flows directly by gravity to the pumping station, while the flow through the distributing main is under a head of from 35 to 60 lb. pressure. The tunnel when properly built and connected is good for a long term of years with practically no cost for repairs and maintenance, while the cast-iron pipe may last from 15 to 40 years.

The comparison of cost for carrying water through an 8-ft. tunnel on the basis of construction alone for the 100,000,000-gal. supply is from $15 to $20 per ft. as compared with $60 to $80 per ft. for the 48-in. pipe, or $80 to $100 through a series of 36-in. pipes.

A 10-ft. circular tunnel through earth costs from $20 to $26 per ft. and has a capacity of 150,000,000 gal. (with 3-ft. velocity) per 24 hr., thus delivering an extra 50,000,000 gal. at a cost of $5 or $6 per ft. A 10-ft. shore tunnel run in from the lake, with proper branches starting from an economical point, would supply three pumping stations of 50,000,000-gal. daily capacity. Mains larger than 30 to 36 in. should be used only in special cases in Chicago. The cost of laying a 36-in. main is from $10 to $12 per ft., as compared with $15 to $20 for the 48-in. main. The cost of valves, piping, etc., is nearly 50% more for the 48-in. than for the 36-in. main. The 36-in. main is ample to distribute the water to a 50,000,000-gal. district from a pumping station economically located, so as to pump an equal distance in each direction.

By a system of cross connections with properly located valves and checks, provision can be made for any extra demand for water within the territory of any pumping station. By placing say two extra 12,000,000-gal centrifugal pumps at each station, a surplus for emergency

use could be easily secured. The tunnel designed on a 3-ft. velocity basis would supply this additional demand for water at a nominal loss of head at the station. This extra demand would mean only a slight excess in the cost of pumping.

Pumping stations should not have more than 50,000,000 to 60,000,000-gal. nominal capacity. Larger units of supply mean larger districts for each unit, and greater lengths of distributing mains. This includes larger pipe with increased cost of maintenance. There is also higher cost for pumping due to the higher pressure maintained at the station to overcome the greater friction head in the pipes. The pressure throughout the large district will have a greater variation. The 50,000,000-gal. unit means a more uniform pressure throughout the district, with a lower average pressure and consequently a reduced cost of pumping.

The city should be laid out, as stated, in definite sections, hexagonal in form where possible, the plan showing just how much is covered in each section. The pumping station should be situated in the center of the distributing or supply system.

The city has now on its hands cribs that should be relocated and designed along correct lines, tunnels that are in a number of cases useless, with hydraulic conditions that govern the flow of water so abnormally bad that the capacity of the tunnel in instances is reduced fully 50%. It has useless parallel water mains with many other errors at different points. The enormous cost of the Chicago water system shows the errors made in the construction, as we now have it. A cost some $20,000,000 higher than it should be still leaves the whole system lacking in many essential features.

The city could appropriate the electrical power developed by the Sanitary District to supply a large part of the power for operating the pumping stations.

One of the first problems to be taken up is to make proper hydraulic surveys to lay out the 50,000,000-gal. districts; and to ascertain the economical center for the location of the pumping stations. From these centers the tunnels can be laid out, and then the locating of the intake cribs would be undertaken. Beginning at the extreme north or south end of the city the new districts could be laid out and work started on the new design when a sufficient area had been surveyed to make the proper number of pumping stations or 50,000,000-gal. districts to represent the capacity of an economically designed lake tunnel and intake crib. Other portions of the city could then be covered as fast as funds were available to meet the necessary construction expense. In building a new tunnel system to provide for present needs, a certain amount of excess tunnel capacity should be provided to care for certain future territory that will be added to the area of the city. This also should be provided for, up to the economic point where the additional cost would more than cover the benefits derived, and a new or separate system called for.

Auxiliary or booster stations that draw their supply from water mains should not be built. The country is so level throughout the whole extent of the city that each portion or district could be given the proper pressure head by means of check valves and other devices of this nature.

The new design or layout for the water system of Chicago would mean very many more tunnels, and of greater lengths. The first cost of these should be their final cost. It means also the elimination of many miles of large water mains, the first cost of which is very large, with great expense for repairs and maintenance. A system of cross connections could be devised for these tunnel systems such that if one unit or pumping station is thrown out of service temporarily no serious lack of pressure would be felt at any locality.

The methods of procedure as now carried on in the alterations and additions to the present stations, only makes the problem more intricate and costly to solve, and it is desirable to undertake as soon as possible the design of the proper system to meet efficiently and economically the required ends.

The Performance of Engineering Work by Manufacturing Concerns

The relation of manufacturers' engineers to consulting engineers in the development of electric traction on railways was discussed at the last meeting of the New York Railroad Club as reported in our issue of Apr. 9, p. 809, and the same relations in the mining engineering field were discussed at the meeting of the Western Society of Engineers in Chicago, on Apr. 6. A paper on "The Engineering Opportunities in Our Coal-Mining Fields," was presented by Andrews Allen, and a considerable part of this paper dealt with the subject noted above. We give below some extracts from this part of the paper, with a brief summary of the lengthy discussion which followed it.

The construction work in connection with mining plants is handled in various ways: 1, by the owner's engineering organization; but only the largest companies can afford such an organization of can provide work or varied experience enough to keep their men abreast of the times; 2, by engineering manufacturers or contracting firms; 3, by firms of consulting or constructing engineers retained by the owner to study conditions, draw plans and specifications, let contracts for material or labor, carry on the field work on company account or supervise it, if done by contract.

The engineering development of coal mines in the West has not kept pace with their commercial development. This is due in part to the newness of the art, the rapidity of its growth, and the unavoidable crudity of new things where we learn our lessons in the hard school of experience. But the lesson would have been learned much sooner, and much better results generally obtained if professional engineers had been more frequently entrusted with the planning and construction of mining plants.

Most operators seldom draw on specialized engineering services for which they have to pay directly, but content themselves with such so called "free services" as they can get from engineering manufacturers. The combination of the mine operator and the sales engineer has not tended to a broad and comprehensive foresight covering future development, or even to well balanced and mechanically efficient plants. The place of the contractor or manufacturer should be secondary to the designer, and it would be more consistent to give away a manufactured article with the design than to give away engineering services with the manufactured article.

The commercial, manufacturing, or sales engineer has his field, no less important and necessary; but neither he alone, nor any combination between him and the operating management, can take the place of the competent consulting, designing or constructing engineer.

All construction propositions should have competent engineering direction in the sole interest of the owner; any other arrangement is dangerous and unsatisfactory. Whether the engineer in charge is a salaried employee of the operator or an engineer in independent professional practice, his relation to the work should be such that he is free to do his

st in the sole interest of the work itself and of the owner. nd the contractor or manufacturer is also able to give better nd more efficient service when he is relieved of general esponsibility and can devote himself to doing his own work nder definite conditions and intelligent direction.

The engineer to handle such a proposition must be absolutely unbiased and must therefore have no commercial ties or affiliations. He must have nothing to sell or exploit but his brains and ability. He must draw on the manufacturer and the manufacturing engineer on the basis of merit only and in the sole interest of the work.

Where manufacturing concerns devote a high-priced engineering organization to furnishing engineering services for which they are not directly paid, not only is the result essentially unfair, for one customer pays for the engineering expense of from three to ten others, but the efficiency of the plant as a manufacturing concern is decreased because most of the energy of its best men is diverted from the business of perfecting its product and processes, which should be its principal concern.

If all engineering manufacturers gave free engineering services they would soon be eaten up by tremendous overhead charges, which would cause them to fall easy victims to such concerns as devote their ability to manufacturing alone. These firms must, of course, have their engineering departments, but there is plenty of work for them to do without infringing on the field of general engineering, and when they do general or special engineering work they should make a direct charge for it and thus relieve the manufacturing department of its burden and play fair with all of their customers.

Wherever special designs have to be made, wherever the installation involves the assembling of numerous elements to furnish which the manufacturer would in fact be a jobber, or where the installation involves careful examination and analysis of conditions and elaborate study plans to determine what should be done, the best results can be secured by an independent engineer directly in the pay of the owner.

On the other hand, where a machine (using this word in a broad sense) is manufactured complete by an engineering firm, and where its uses and duties are so definitely known that they can be made subject to a definite guarantee under prescribed conditions and where the engineering work is principally an adaptation of standards, the design should generally be made by the manufacturer, although, even here, the independent engineer can be of the very greatest value to the owner in analyzing and comparing the proposition. Where competitive designs are made by manufacturing companies the conscientious and competent firms are sure to have a hard time, and frequently lose out to those who skin down the requirements.

It must not be assumed that an installation handled by a consulting or a constructing engineer is likely to cost more than if plans are made by the engineering manufacturer. The reverse should be the case, for the engineering work is done thoroughly and only once, and the material is furnished and the work done under rigid specifications which put each bidder on an equal basis of merit and lower his cost by removing uncertainties and reducing engineering and contracting expenses to a minimum. On this basis only is it possible to obtain fair competition, resulting not only in lower prices but in a helpful stimulus to industry. Each specialty can be bought from the best manufacturer in that line and welded by the engineer into a completed whole.

Where an installation planned by an engineering manufacturer seems to cost less, it is usually because less attention has been paid to operating efficiency, maintenance and future requirements, which are the very things that count, and where a dollar spent in the beginning is frequently worth ten dollars afterward.

In the discussion, Mr. Armstrong (C. & N. W. Ry.) said that while the great field for the manufacturing engineer is in the development of standards of production and standard machines, the adaptation of these standard productions to their various uses should be worked out by the engineer who can study all the conditions affecting the plant in which they are to be used. Few manufacturing concerns could employ such engineers, and if they do, then in bidding on the same proposition each has to pay its engineering organization, and this charge must be added to the cost of production of the concern which secures the contract. If the design is put in the hands of a consulting engineer this cost has to be paid but once, and the several manufacturers do not have to include overhead charges of this sort.

Mr. Rasmussen spoke in favor of work being done by the manufacturers' engineer, but missed the point of Mr. Allen's statement, to the effect that such an engineer, however capable, is limited to advocating his own firm's design or specialty, whereas the independent engineer may see that some other specialty will better meet the needs or conditions, and is free to adopt the latter. He referred also to a paper by M. L. Hyde, read before the Canadian Mining Institute, which did not favor the employment of independent engineers.

Mr. Garcia (Chicago) pointed out that Mr. Hyde's paper stated that in building a mine tipple, for instance, he would ask certain manufacturing companies to send their representatives "which they do without cost." If Mr. Hyde believes this to be the case, evidently he has much to learn, and his further proposal to borrow a draftsman from the manufacturer for general drafting work certainly could not be considered good practice for either the mining concern or the manufacturer. Mr. Garcia also referred to coal-mine engineering as a promising field for the young engineer and one which commands better pay than many other branches of the profession.

Mr. McCullough (Chicago) pointed out that when the mine operator has several plans submitted to him he is not able to make a choice on the basis of their respective merits, while the independent or consulting engineer is able to do this for him. The condition exists, of course, that the manufacturers offer engineering service free of charge, but it is evident that the cost of this service must be paid somehow. The point is, not that there is antagonism between the consulting engineer and the commercial engineer, but that the engineer and the manufacturer are two separate and distinct entities. Mr. Reichmann (American Bridge Co.) also thought that the employment of a consulting engineer to design a plant before the manufacturer is asked to bid on it eliminates a large amount of engineering waste as compared with a case where various firms send men (ostensibly without charge) to lay out or design a plant.

Model New Industrial Town Planned, Near Pittsburgh, Penn.—One of the largest building operations in the Pittsburgh district in recent years is the new plant of the American Zinc and Chemical Co., a subsidiary of the American Metal Co., of New York, which is one of the largest producers of zinc in the United States. This company has recently purchased about 2500 acres of coal and about 250 acres of surface at Burgettstown, Penn., some 27 miles below Pittsburgh on the Pan-Handle division of the Pennsylvania Lines West of Pittsburgh.

What is known as a one-unit plant will be erected at once, which will have a capacity of 40,000 tons of sulphuric acid and 20,000 tons of zinc annually. The plant will be enlarged as fast as the situation warrants until a capacity of two or three times that amount is reached. There will be 17 buildings in the first unit, all of steel-frame and of mill construction type. The initial investment will be around $2,000,000 and when the plant is completed, possibly in about three years, it is anticipated that there will be $5,000,000 invested.

A shaft will be sunk and coal mining operations will be commenced at once. The plant will give employment to possibly 500 men at the start and eventually 1500. This means that a new town will have to be built to accommodate the families of the workmen, and it is the intention of the company to make the town a model one both from a utilitarian and æsthetic point of view. Langloth will be the name of this new town.

New Coal Pier, Norfolk & Western Ry., Lambert Point, Va.*

By W. P. Wiltsee†

SYNOPSIS—A coal pier capable of handling 5400 tons per hour just completed in Norfolk Harbor. Coal is brought from the mine; the cars are all sorted in a hump yard and the coal is then weighed and dumped into special motor-car units, which are elevated to the upper level of the pier and dumped into the required hopper in the pier. Coal ships and barges may lie alongside and draw off from hopper. Special features are the combined use of gravity and mechanical operation, the foundations and the steelwork.

A larger tonnage of bituminous coal is loaded on the vessels in Norfolk Harbor than any other harbor in the United States. This tonnage for the year ending Dec. 31, 1913, amounted to 11,993,658 tons, and was handled by the three railroads entering this harbor as follows: Norfolk & Western Ry., 5,598,716; Virginian Ry., 3,283,925 and Chesapeake & Ohio Ry., 3,111,017 tons. The largest dumping of coal in any one month was made by the Norfolk & Western in the month of December, when 514,020 tons of coal were handled over its piers then in operation. In order to increase the pier capacity to care for this growing trade, the pier described herein was started early in 1912 and was put into service in December, 1913.

There are about 40 different classifications of coal handled at these piers, which makes it necessary to have several boats alongside of the pier at one time and the facilities such that one car may be dumped into a vessel and the next car into another vessel, or even into another hatch of the same vessel, if that vessel is taking a mixed cargo of coal. It was, therefore, not feasible to have the coal dumped direct into the vessel with the mechanical car dumper as is a frequent practice at coal piers, but an intermediate pier car had to be provided so that the classification could be easily made on the pier.

In brief, each car is brought by gravity from the Lambert Point hump yard across the scales to an incline, where a barney pushes it up to a coal dumper. At the dumper the contents of the car are emptied into an electric motor car, which runs to an elevator in which it is lifted to the upper level of the pier, run off on tracks on that upper level and dumped, through bottom opening hoppers, into the proper bins, whence the coal is drawn off into the boats lying alongside.

The pier is 1200 ft. long outside of the bulkhead line, with slips on each side having 32 ft. of water and 160 ft. wide at the bulkhead extending to 300 ft. wide or more at the outer end of the pier. The top of the pier is 90 ft. above low-water line and level. The new construction included dredging for the proper depth, filling to make ground for the new classification yard, piled concrete foundations for the scales, dump, elevator and pier and erection of the steel framework of the pier and of the various mechanical devices on it.

Lambert Point Yard as completed contains 52.5 miles of track, about one-half of which was added at the time of making these improvements. The receiving yard, into which coal is received, will hold 3300 cars, the gravity yard for the new coal pier will hold about 400 cars, and the empty yard for the coal pier will hold about the same number. There is in addition to this a coke yard, which will hold 130 cars, a gravity yard for coal pier No. 3 which will hold 60 cars, and a shop yard holding about 300 cars.

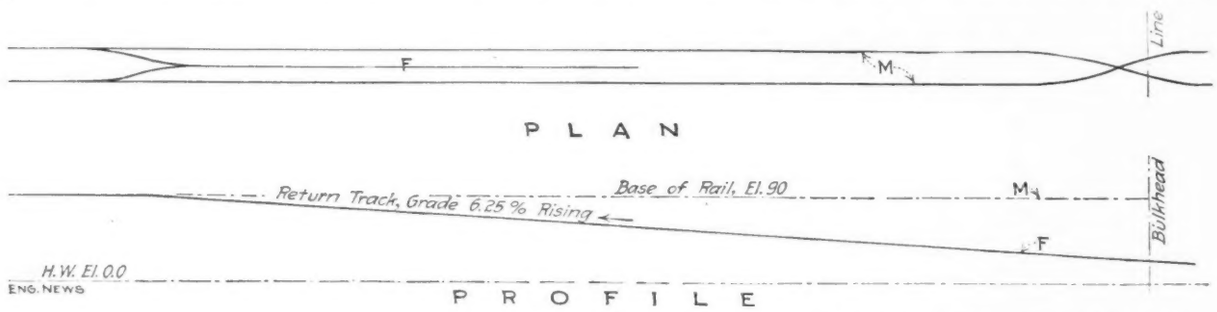


Fig. 1. Plan and Profile of Coal Pier No. 4, Lambert

Operation

The operation of the pier, as described below, may be understood better by reference to the accompanying diagram (Fig. 1) showing the plan and profile of the pier and yard.

Weighing—The coal cars from the mine are pushed by locomotives into the gravity yard from which each car is run by gravity and controlled by a car rider at the brakes reducing speed as it crosses the scales where, by means of automatic weighing devices, a record of the weight is obtained. Each of these scales has a capacity of over 200 tons.

Dumper—After these cars are weighed they run over the mule pit to a point between it and the approach to the car dumps. The car is then brought up the incline to the car dumper by means of this mule or barney controlled from the operator's house (Fig. 2).

Each mule-haul mechanism consists of two 225-hp. motors geared to a drum. The haulage rope from this drum is led around deflecting sheaves, located under the trestle and over sag carriers to the mule car. The drum

*Prepared in part from an address delivered Mar. 2, 1914, before the Roanoke Engineering Club, Roanoke, Va.

†Assistant Engineer, Norfolk & Western Ry., Norfolk, Va.

to which this haulage rope is fastened is controlled by brakes operated by hand or foot levers and also solenoid-operated brakes to provide for any sudden failure of current from any cause. After the car is placed on the platen, or movable platform mounted on a cradle (Fig. 3), it is tipped by means of ropes passing around the underside of the cradle and over sheaves at the top of the framework and wound around drums located in the framework near the bottom on the outside of the dumpers. The speed of each car dumper is so regulated as to dump a maximum of 30 cars per hour, and is designed to handle road cars from minimum sizes up to 90-ton capacity.

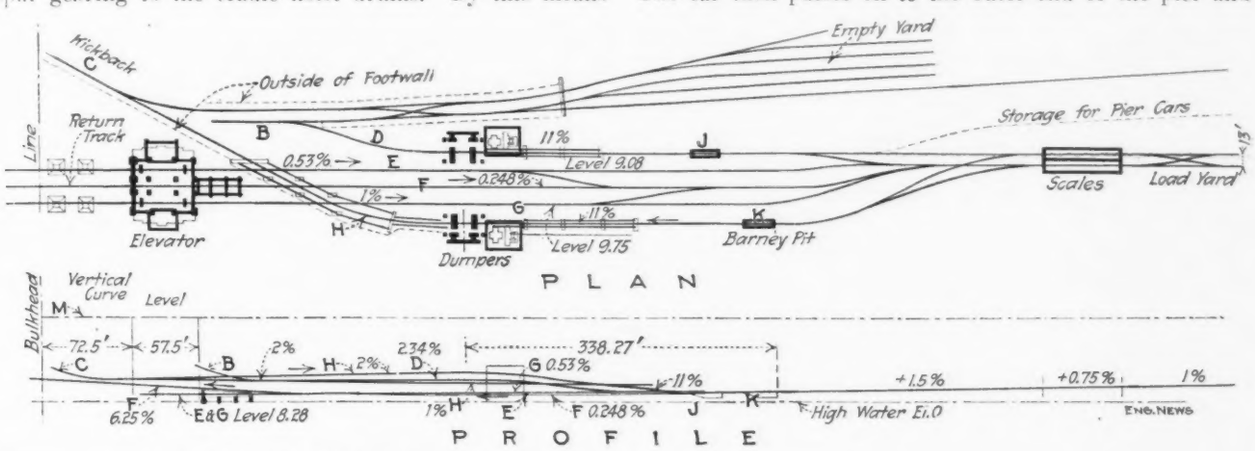
The first motion of rotating releases the levers holding the movable platform in its position, and it, with the car, travels sideways until the side of the car is against the side of the cradle, the car is then clamped into position by four heavy steel beams automatically operated by heavy counterweights traveling in guides at the side of the dumper. Each car dumper is turned by means of two 200-hp. motors connected by proper reduction of spur gearing to the cradle hoist drums. By this means the car is inverted and the coal is dumped into especially constructed electric-driven pier cars, which will be described later.

The cradle of the car dumper is then turned to its original position by means of counterweights and dynamic brakes and the next car up the incline to the car dumper pushes the empty road car off this cradle where it runs by gravity on a return track with a kickback to the empty yard.

Elevator—The pier car then runs by means of overhead-trolley system to the elevator. These two elevators (Fig. 5) are built in one framework and form a support and guide for the platforms used in hoisting these pier cars to the top of the pier. These platforms, upon which the car runs, are operated in guides from the lower elevation to the top of the pier, a height approximately 80 ft., the center portion of this elevator tower is constructed so as to allow the empty pier cars to return down the grade from the top of the pier. Each of the hoists is operated by two 600-hp. motors geared to winding drums upon which the operating ropes are wound, these ropes pass over deflecting sheaves at the top of the tower and around sheaves in the framework of the elevator platform and anchored at the top of the tower. The platforms are counterbalanced by means of heavy weights running in guides at the sides of the elevator. These weights are of such sizes that the unbalanced load traveling in either direction will be approximately the same.

After the car has been elevated to the top of the pier, it is then run off by means of trolley. The elevator is lowered by raising counterweights.

Classification Pier—After the pier car is raised to the top of the pier it runs off onto a movable girder 50 ft. long, which is hinged at the end next to the pier and movable at the end next to the elevator. When the platform of the elevator is raised to this girder, it picks it up and automatically aligns the rails by means of guides on the platform and on the movable girder. The end of this girder has a vertical movement of 2 ft. in all. The platform of the elevator is provided with car stops between the wheels of the front trucks, which operate automatically with the raising of the platform to prevent movement of car on platform while hoisting. The car then runs to the chute designated by the pier foreman and the coal is immediately dumped into a hopper by means of discharge gates in the bottom of the car operated by air. The car then passes on to the outer end of the pier and down the return track for its next load (Fig. 8). The coal in this hopper is held by means of undercut gate at the mouth of the hopper. These hoppers are so constructed that the angle of inclination of all the parts is the same, thus leaving no place for coal to stop.



Point, near Norfolk, Va., Norfolk & Western Ry.

Chutes—When the undercut gate is opened, the coal drops in a vertical chute at which there is another gate, which is then opened and the coal runs out the hinged chute into the vessel (Fig. 7). These chutes are so constructed that the hinged portion of the chute can be raised vertically alongside of the pier when not in use, and lowered to an angle of about 60° below the horizontal for loading. This hinged portion of the chute can be moved bodily up and down in the vertical part of the chute by means of a sliding box to a position near the end of the chute which will be 47 ft. above the water when inclined at an angle of about 35°, at which the coal runs freely, this chute can also be lowered until the end of the hinged portion is within a few feet of the water. The hinged portion of this chute also has a side movement of 12 ft. each side of its normal position. These chutes are raised and lowered and the gates are operated by means of geared machinery operated by hand on top of the pier.

Pier Cars—The electric-driven pier cars are steel cars

(Fig. 6) mounted on two 6-wheel trucks, and have a capacity of 3900 cu.ft. level full. The bottom is constructed to hold a hopper with discharging gates, which are arranged in pairs. These cars are operated by means of two motors, one of each is geared to an axle of each truck and provided with dynamic braking attachments for regulating the speed when coasting down the grade. The operator's cab is at the front end of the car, and at the opposite end of the car there is an inclosed space for resistance, storage tanks, etc. The gates in the bottom of the car can be operated independently, separate cylinders being provided for the purpose. The total length of the double opening of the gates is approximately 26 ft., which is within four feet of the length of the hopper on top of the pier. The cars receive their current from overhead trolley wires which are provided on top of the pier and down the return tracks as well as on the ground level. These cars are designed to operate, when loaded, at a speed of 1000 ft. per min. on a level grade, and when empty, at a speed of 1400 ft. per min. on level grade.

Tonnage Capacity—The total tonnage of coal dumped over this pier in one hour's time should be 60 cars of coal, which if the cars are of the 90-ton capacity, would equal 5400 tons of coal per hour, and with the ordinary car averaging 50 tons would equal 3000 tons of coal per hour, which means that this pier will be able to handle at least 3000 tons more coal per hour when all large cars are used, or 1000 tons more coal per hour when ordinary cars are used, than Pier 3 now in use at Lambert Point, or any other coal pier in Norfolk Harbor.

When the road car passes the scales, the clerk in the scale office writes on a telautograph the consignee, kind of coal, car number and weight, which writing is immediately produced on a similar machine in the clerk's house at the car dumper. The clerk takes this paper and marks thereon the number of the pier car into which this coal is dumped and hands the slip to the motorman of the car who delivers it to the stevedore's office on top of the pier where he receives instructions into which chute or hopper, they being numbered, he is to dump the coal.

Electric Station—All of the machinery for this pier is electrically operated. A substation was built just south of the scales for reducing and converting the current which is furnished by the Virginian Railway & Power Co., over a 11,000 volt, a.c. line. Two transformers are used in this substation for reducing the voltage for the converters by which the current is changed to direct current and furnished to the machines at the pier on a 500-volt line. These machines are in duplicate, so that one machine is used at a time and the other one held in reserve in case of accident. In this substation, there are also three transformers for reducing alternating current to be used in the motors at the shop buildings and for lighting purposes.

Construction

The construction operations may be divided roughly into building the bulkheads and breakwaters, dredging the site, building the pier fender, driving piles for the pier-column bases, foundation work for scales, dumper and elevator and erection of the final steel frame.

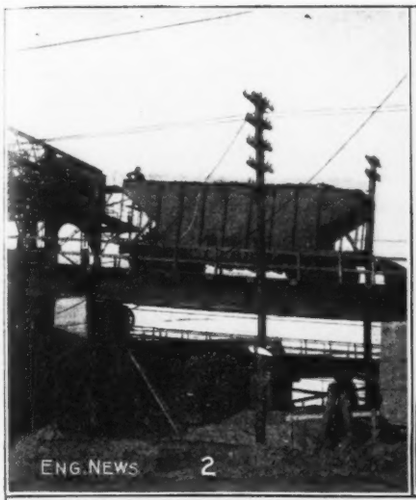
About 1900 ft. of new breakwater had to be built north of the new pier site, an old breakwater removed from the site itself, and the bulkheads built at the shore end of both slips. All of these structures were of timber framing and piles, some 90,000 lin.ft. of piling and 250,000 ft. b.m. of framing timbers being used. The dredging, done by suction dredges, covered some 20 acres and totalled 668,000 cu.yd. All spoil was placed inshore in the new yard or around foundations to yard structures. The pier fender (Fig. 10) is of creosoted timber pile and frame construction and totaled 72,400 lin.ft. of piling and 416,000 ft. b.m. of framing.

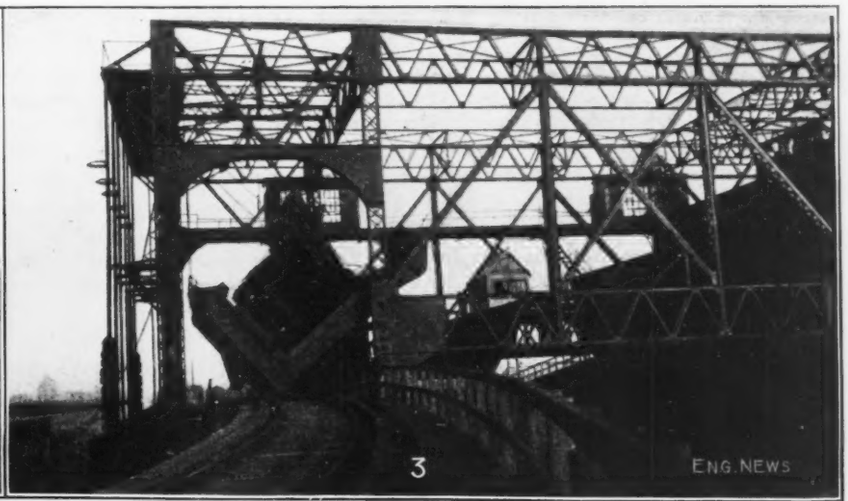
Cylinder Foundations—The foundations for the pier columns were made by driving pile clusters, inclosing them in a steel cylinder 18 ft. in diameter and filling that cylinder with concrete. Each pile cluster was made up of 65 piles varying from 25 ft. to 70 ft. in length. There was a total of 108,542 lin.ft. of piling driven in these cylinder foundations and on 2400 piles a water jet had to be used in order to secure penetration enough into the sand and gravel at the bottom. The largest number of these driven in one day was 54 piles. The piles were placed in the telescopic leads under the follower above water, and were then lowered into position and driven until the top of them was about 27 ft. below low water. At first, these piles were started so that the top of them came about one foot inside of the cylinder line, but it was found that they spread somewhat in driving, making it difficult to place the cylinders over them. After this, the piles were started closer together so that there was a clear space of 2 ft. outside of the piles and no more trouble was encountered. It was also found that these piles spread in driving out close to the sides of the cylinder.

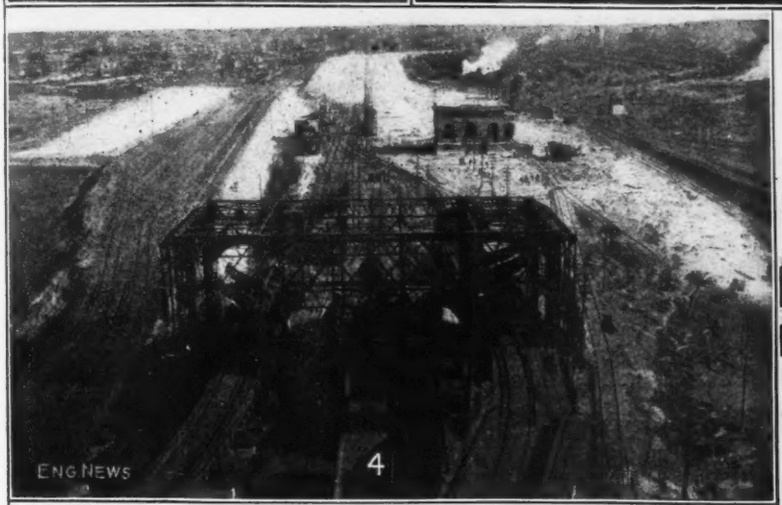
The cylinders were 41 ft. long including a temporary section of 7 ft. on the top of them and weighed about 17 tons. It was necessary to have a large derrick boat for handling these and placing them properly as they had to be lifted over the top of the pier fender, which it was necessary to construct before placing cylinders in order to have something to hold these cylinders in position until they were filled with concrete.

The cylinders were erected on the dock between the warehouse at Lambert Point and moved around on the derrick boat as they were needed. Considerable difficulty was encountered at some points in sinking these cylinders, where the bottom was hard, down to the proper depth, as the water had been dredged to a depth of from 32 to 34 ft. along this area, while the bottom of the cylinders were to be about 35 ft. below water. These cylinders, on account of the action of the tides, and the strong wave action during rough weather, had to be held very firmly in position at the top, and it was necessary to securely brace the pier fender and to hang them and brace them to this fender in order to hold them in the proper position.

After the cylinders were placed for the foundations of the pier proper, it was necessary to pump out of them several feet of very soft mud which had collected in the bottom of the slip after the dredging had been done. Holes were provided below low-water line in the sides of the cylinders in order to equalize the water pressure in the cylinders, and bags of cement were placed around the inside of the cylinder to prevent mud and water from breaking in under them. This mud was pumped out by







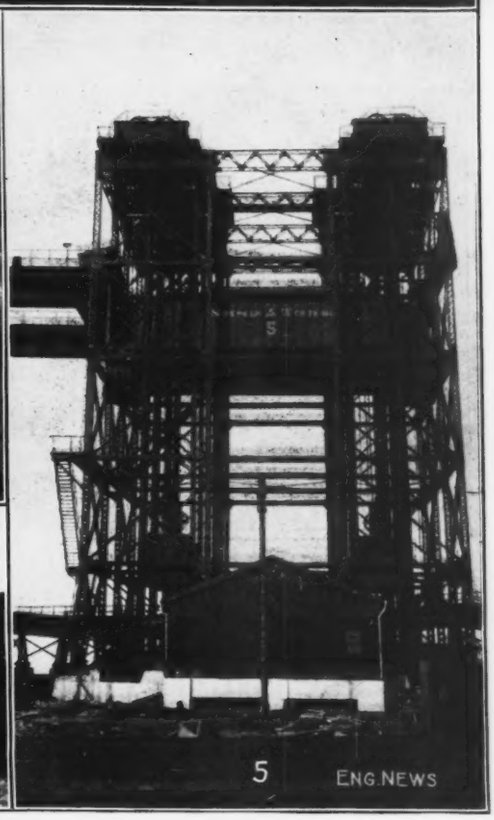


FIG. 2. BARNEY PUSHING MINE CAR UP INCLINE TOWARD DUMPER

FIG. 3. CAR BEING DUMPED

FIG. 4. LOOKING FROM TOP OF ELEVATOR DOWN ON CAR DUMPER AND TOWARD SHORE END OF PIER

FIG. 5. SIDE VIEW OF ELEVATOR

FIG. 6. ONE OF THE PIER MOTOR CARS

FIG. 7. WATERSIDE VIEW OF PIER WITH HOPPERS

FIGS. 2 TO 7. VIEWS AT NEW NORFOLK & WESTERN RY. COAL PIER

an 8-in. centrifugal pump after which a couple of feet of clean gravel was deposited in the bottom of the cylinder around the piles in order to hold in its voids any remaining mud that may be there. A concrete seal of 1:2:4 concrete was next deposited by means of a drop-bottom bucket of 1-yd. capacity around the piles up to and slightly over the tops of most of them. Two extra bags of cement per yard was added to this sealing concrete. In most of the cylinders there were 15 or 20 piles which extended above this concrete seal, all of which were found to be in good condition.

After this concrete seal had set, after one week the cylinders were pumped out dry, and the laitance, mud, etc., were cleaned off from this seal until good hard concrete was found. Concrete was then placed in the open up to the top of the permanent cylinder which was about the low-water line, or one foot below, and before this concrete set, ¾-in. steel rods, 15 ft. long, were placed in the top of it as well as five pieces of old rail 3 ft. long, one at each corner and one in the middle so as to tie the pedestal ing concrete plant. Material was received for this work in cars. Before this foundation concrete could be started, considerable soft mud and water had to be removed from the pile footings. Water was emptied by means of a hose under pressure around the foundation, and a good deal of soft slimy mud was pumped out from around the piles. This was afterwards refilled to the low-water line, or about one foot below the tops of the piles, with clean sand. Instead of making the foundation course in several separate footings, the whole area was covered with concrete about 4 ft. thick, heavily reinforced with old rail as a precaution against vibration in these machine foundations and to provide extra stability to the whole structure. The neat work of this structure required some very complicated form work and the placing of over 400 anchor bolts, some of which were very long on account of the great uplift. Mechanical bond was made between the foundation course and the neat work by means of old rail 3 ft. long, placed vertically, and the neat work was carried on in sections completed to the top without

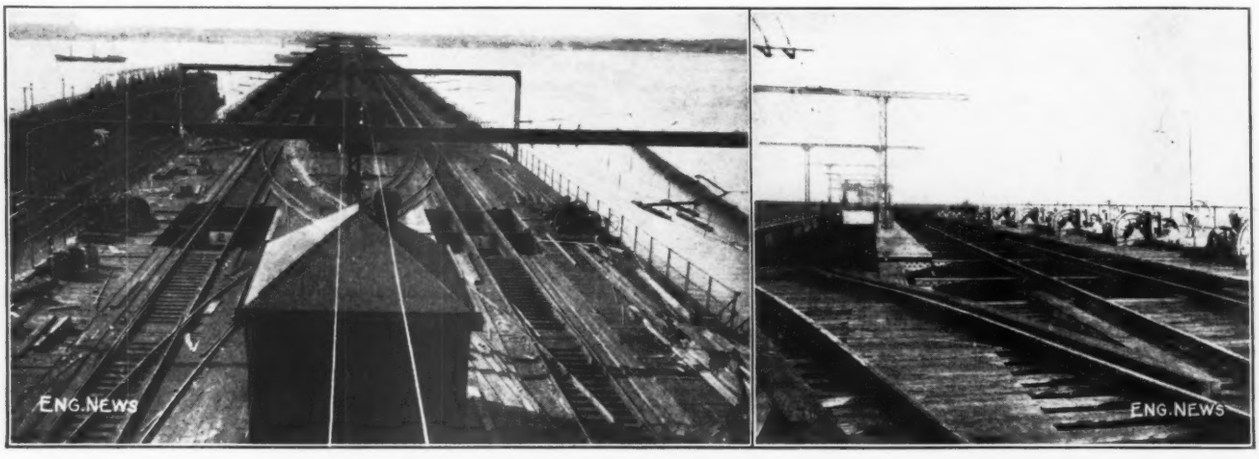


FIG. 8. FROM TOP OF ELEVATOR LOOKING TOWARD WATER END OF PIER

FIG. 9. HOPPER-OPERATING MACHINERY

FIGS. 8-9. VIEWS ALONG TOP OF PIER

to this concrete. These ¾-in. rods extended to the top of the pedestal in order to give additional strength to this footing (Fig. 11). The broken stone and sand were handled by a derrick on this boat from barges lying alongside to storage bins over the concrete mixer, which fed into measuring bins before going into the mixer, the cement was handled by this derrick to a platform above the mixer. Very good concrete was mixed by this machine, and as much as 60 yd. per hour were deposited on several occasions. Timber forms were used for the pedestals, and after this concrete was placed and the forms removed, the temporary sections of cylinders were also removed.

The sealing of these cylinders was first attempted by using a tremie, but it was soon found that satisfactory results could not be obtained by this method as the tremie could not be moved around in between the piles and having to raise it above the piles to move it to another location caused all the concrete to run out, thereby losing entirely the principle of the tremie.

ELEVATOR FOUNDATIONS—The foundations for the elevator were concreted from a plant erected on the land with a tower and chute similar to that used on the floating stopping. The elevator footings were connected with the pier footings by concrete struts.

FOUNDATIONS FOR DUMPERS, ETC.—The foundation for the car dumpers was reinforced with old rail and struts of concrete were built between the two dumpers and connecting the separate footings. Each car dumper is separate in itself, but is connected by the steel superstructure, and also in the foundations by the struts. There were over 300 anchor bolts used in this structure, and 1400 cu.yd. of concrete.

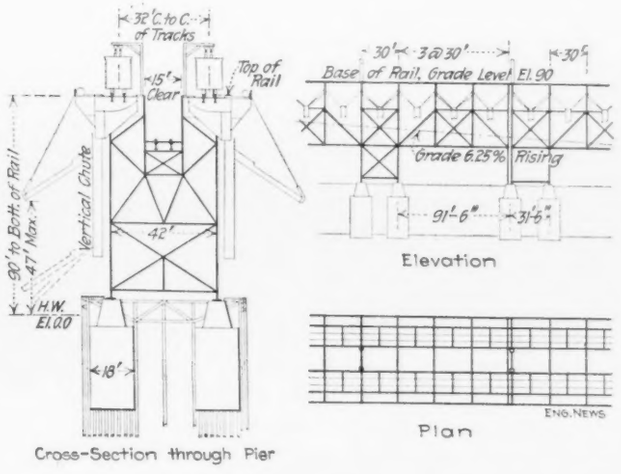
The approach tracks to the car dumpers as well as the return overhead track from the south car dumper were supported on concrete pier foundations with steel girders. For the timber trestle part of this return track, concrete footings were provided so that in the future this could be renewed in steel. The scale foundations are built for two 200-ton track scales, with tracks 13 ft. c. to c. This masonry was waterproofed to prevent leakage, and such water that runs into them from the top is drained off into a well on the outside and pumped out after it accumulates.

SUPERSTRUCTURE—The superstructure of the steel pier proper was erected by means of travelers on top of the

pier. The steelwork for the elevator and the tower on the shore end of the pier was erected with a large locomotive crane with a boom about 90 ft. long.

After this was erected, a double steel traveler was erected on the top, composed of two booms 95 ft. long, each good for 16½ tons at a radius of 65 ft., and for 10 tons at a radius of 95 ft. All the heavy pieces were erected with this traveler. This traveler was followed by a smaller one with 60-ft. boom good for 4 tons at a radius of 45 ft., erecting the smaller parts, including the bunker plates, counterweight guides, etc. The steel was assembled on the ground, hauled by means of locomotive cranes to where it was placed in barges and towed out along the side of the pier, within reach of these travelers. The work of erecting this steel progressed very rapidly; there were about 8000 tons of steel erected in all, and about 300,000 field rivets driven.

The general design of the steelwork for this pier consisted of alternate 30-ft. towers and 90 truss spans with panel lengths of 30 ft., which allowed for the spacing of the chutes 30 ft. apart. The steelwork is so arranged



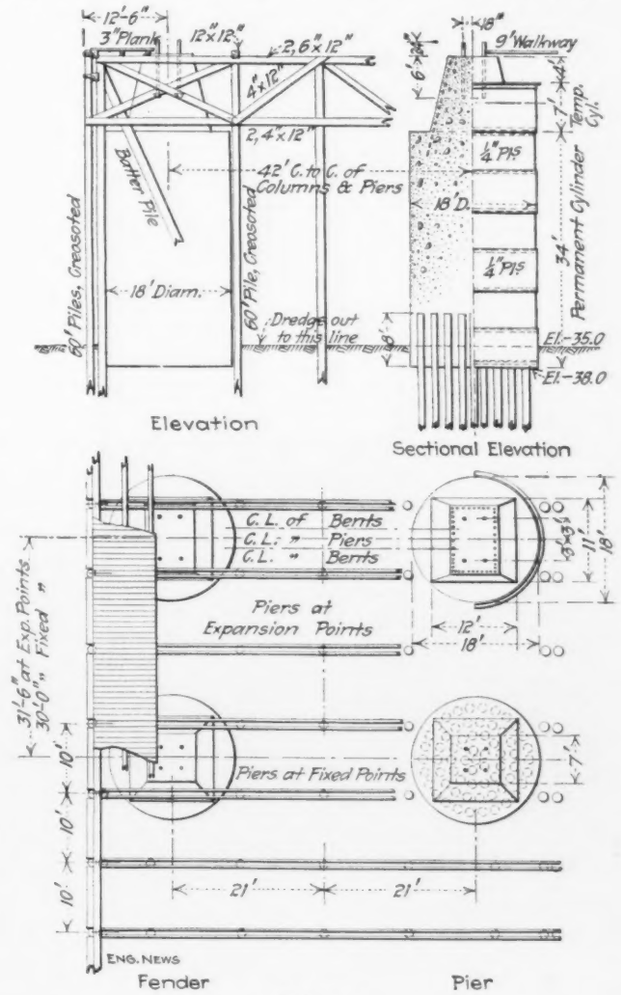


FIG. 10. SECTION THROUGH HOPPER END OF PIER AND DETAILS OF CYLINDER PIER FOUNDATION

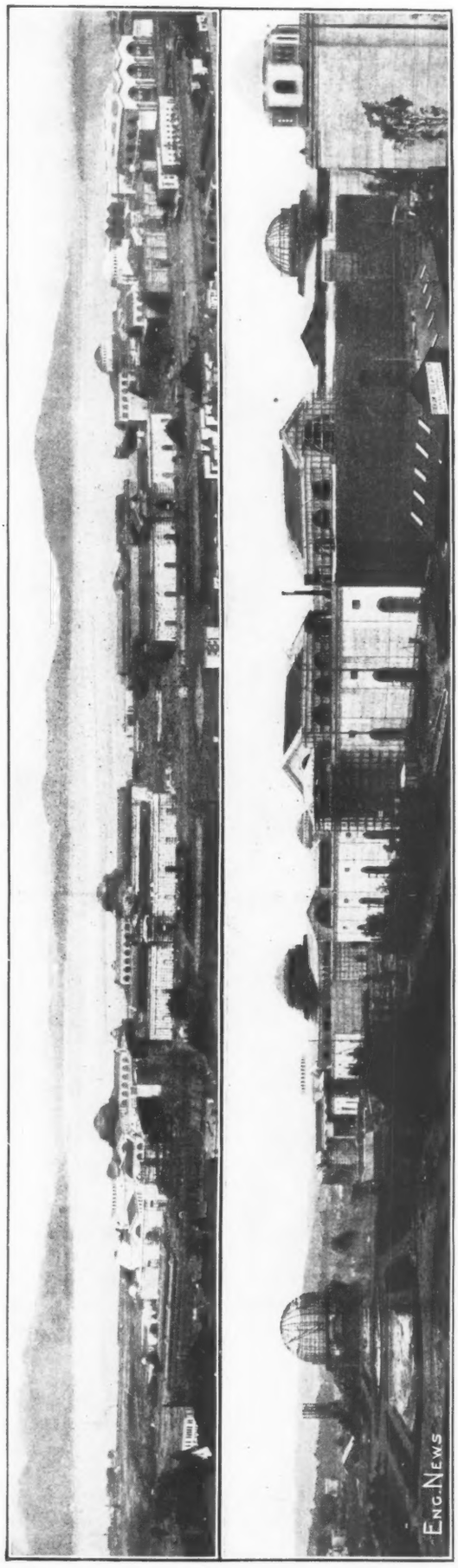
FIG. 11. VIEW OF PIER COLUMN BASE IN STEEL CYLINDER

that the empty pier cars return to the ground on a track through the middle of the pier with a grade of 6.25%. Expansion joints are provided at four bents on the pier. At each of these expansion joints the steelwork is entirely separated by building two sets of columns 3 ft. apart c. to c.

PERSONNEL

Henry Steers, Inc., of New York City, did the dredging, bulkheads and foundation work for the pier proper and the elevators. J. P. Pettyjohn & Co., of Lynchburg, did the foundation work for the car dumpers, tracks around the same, scales, and built the substation. Virginia Bridge & Iron Co., of Roanoke, furnished and erected the steelwork for the pier and elevators. Wellman-Seaver-Morgan Co., of Cleveland, furnished and erected the elevator machinery, structural steelwork for the car dumpers and car-dumping machinery. The Link Belt Co., of Philadelphia, furnished and erected the chutes and their operating machinery. Westinghouse Electric and Manufacturing Co. furnished the machinery for the substation. Fairbanks-Morse Co. furnished the scales. Railway company forces erected the scales, machinery in substation, trolley and lighting system, trestle work around the car dumpers, made the fill for the gravity yard, and laid the tracks.

The work was started under the direction of Chas. S. Churchill, formerly Chief Engineer, and later finished under the direction of J. E. Crawford, the present Chief Engineer, who together with C. C. Wentworth, Prin. Asst. Engineer, designed the plant. The work was directly in charge of the writer, assisted by L. L. Kelly, Resident Engineer, and party.



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THE PANAMA-PACIFIC EXPOSITION BUILDINGS AT SAN FRANCISCO

(Upper photograph taken Feb. 20. The lower view, taken in March, is looking along the front of the buildings in the foreground of the upper view.)

Progress on the Panama-Pacific Exposition

Rapid progress is being made on the Exposition buildings at San Francisco. The following information as to recent progress has been furnished us by Mr. Markwart, Assistant Director of Works, whose papers on the Exposition in our issues of Nov. 6 and 27 will be remembered.

A complete high- and low-pressure water system has been installed, and the sewers and drains are completed; the grading is essentially finished and road-making is under way. The decorative features and the work on the gardens are well advanced. Of the 63 acres of buildings, 60 acres are completely under roof. Bids are now being solicited on the California Building and the Festival Hall, the only two large structures remaining to be constructed by the Exposition.

The following is a statement of the building progress: Machinery Building, completed; Education Building, 98% completed; Food Products, 95%; Agriculture, 85%; Liberal Arts, 80%; Manufactures, 75%; Transportation, 65%; Varied Industries, 98%; Mines, 98%; Art Gallery, 15%; Horticulture, 50%; Exposition Auditorium (at the Civic Center), 25%; Court of Four Seasons, 50%; Court of Honor, 15%; Main Tower, 10%; Court of Abundance, ready to start construction, and Court of Palms and Flowers, about 5%.

It has been the policy of the Exposition to do all the work by contract wherever possible. There have been let, to date, 225 regular and 250 special contracts. The obligations incurred to Feb. 1, 1914, have been as follows: by regular contract, $7,500,000; by special contract, $1,000,000. The expenses in other directions have been about $2,000,000, showing a total of expenses or obligations of $10,500,000, which indicates that 80% of the work is near completion.

The accompanying panoramic photographs show views of the buildings under construction, the upper taken on Feb. 20, the lower taken near the end of March.

The large steel frame at the left in the lower view is for the dome of the Palace of Horticulture. This dome will be 186 ft. in height and 152 ft. in diameter. When completed it will be covered with glass and at night colored searchlights will play upon the glass from within.

The large group of buildings on the right consists of eight exhibition buildings, four of which face on San Francisco harbor and four of which border upon the south gardens. The buildings facing the south gardens and forming a continuous east and west facade are from left to right, the Palace of Education, Liberal Arts, Manufactures and Varied Industries. The buildings facing the harbor are those of Food Products, Agriculture, Transportation and Mines and Metallurgy.

Looking from left to right the first large white dome is that of the Palace of Education; this dome is 150 ft. in height and 100 ft. in diameter. The next dome, which is of similar proportions, and which has not yet been painted, is that of the Palace of Liberal Arts. Behind the dome of the Palace of Liberal Arts, may be seen the dome of the Palace of Food Products. The next building to the right and prominent in the picture is the Palace of Manufactures, on which the dome has not yet been superimposed. The cross naves in this palace, at the intersection of which the dome will be placed, are 110 ft. in height. The next dome seen is that of the Palace of

Transportation; at the extreme right of the picture appears one corner of the Palace of Varied Industries. In the center of the group of buildings and to the right of the first two domes will be located the lofty Tower of Jewels, which will rise to a height of 433 ft. The tower will be divided by an archway 125 ft. high, through which visitors will enter from the main gates of the exposition into the Court of Honor.

All the exhibition buildings are to be ready to receive exhibits on July 1 of this year. The exposition is to open on Feb. 20, 1915.

Fees for City Surveys and City Engineering Work, Oakland, Calif.

Much interest is always manifested in the fees adopted by or recommended by engineering societies for the engineer's professional services. This is probably due to a total lack of standard and a secretiveness on the part of many surveyors and engineers as to their charges to clients, and to the lack of knowledge of many inexperienced engineers as to what constitute fair charges.

In Oakland, Calif., the City Engineer Department is maintained largely on a fee system. Fees are collected for private lot surveys, private grade surveys, street openings, and from the Street Department on street work covered by engineers' certificates. Work done for the various city departments of Schools, Parks, Playgrounds, Public Health and Safety, Civil Service Board, Municipal Water District, etc., is paid for at fixed rates by those departments.

The Engineering Department under these conditions is not entirely self-supporting, for according to the recent report of the Commissioner of Streets, the income for the fiscal year ending in June, 1913, was about $48,000 against $57,000 for expenses. The expenditure for salaries alone was over $53,000. Nevertheless, the fees and charges are apparently roughly gaged to the cost to the city of performing the work. The additional expense could be accounted for by work done for which it is impossible to make a direct charge against some other city department and by overhead charges incidental to maintaining a comparatively large organization.

The fees and charges in Oakland were established by city ordinance in August, 1911, as follows:

(A) For the survey of any lot, having four straight sides and being outside of the fire limits of said city, the fee to be charged shall be $12 for 50 ft., or less, of frontage and 5c. for each front foot additional. Survey to include a diagram thereof and the setting of four stakes, additional stakes to be charged for at the rate of 50c. each.

(B) For the survey of any lot, as described in (A) but lying within the fire limits of said city, the fee to be charged shall be 50% greater than as fixed in (A).

(C) For the survey of any irregular-shaped lot (lot having more than four straight sides) the fee to be charged shall be at the rate of $20 per day for each field party of three men, and $8 per day for each office man; excepting however, that the fees for irregular-shaped lots, as herein defined, shall, in no case, be less than the fees established upon a frontage basis.

(D) For giving official line and grade of curb or sidewalk in front of any lot of 100 ft., or less, frontage, $5 if done in conjunction with a lot survey, and if done otherwise, 6c. per lin.ft. of curb or sidewalk with a minimum charge of $8.

(E) Upon street work under the general street laws of the state of California, the cost of which is to be paid for by a frontage assessment, or upon street work, the cost of which is to be paid for in such manner as may be agreed upon between property owners and contractor (private contracts), the following shall be the fees, to wit:

FOR SETTING STAKES ONCE UPON:

Sewering or resewering, $6 for the first 100 ft. or less, with 6c. for every additional foot of sewer.

Catch-basins, $5 each.

Grading or regrading, 7½c. per lin.ft. of street, measured along the center line.

Grading and curbing or regrading and recurbing, 10c. per lin.ft. of street, measured along the center line.

Curbing or recurbing with wood, 3c. per lin.ft. of curbing.

Guttering or reguttering, 3c. per lin.ft. of gutter.

Curbing or recurbing with granite, cement or concrete, 5c. per lin.ft. of curbing.

Sidewalking or residewalking, 6c. per lin.ft. of sidewalk.

Culverts, 6c. per lin.ft. of culvert.

Crosswalks, 6c. per lin.ft. of crosswalk.

Grading, curbing with wood and paving with macadam or oil macadam, 15c. per lin.ft. of street, measured along the center line.

Regrading, recurbing with wood and repaving with macadam or oil-macadam, 15c. per lin.ft. of street, measured along the center line.

Paving or repaving with macadam or oil-macadam, 5c. per lin.ft. of street, measured along the center line.

Paving or repaving with macadam or oil-macadam and curbing or recurbing with wood, 9c. per lin.ft. of street, measured along the center line.

Paving or repaving with material other than macadam or oil-macadam, 5c. per lin.ft. of each line of stakes, measured lengthwise of the street.

Masonry work, 5% on the cost of construction, as shown by the contract.

For plan, on private contracts, $5.

For assessment diagram and final certificate, $5.

No fee shall be charged on redressing the surface of improved roadways, unless stakes are set, in which case the fee shall be the same as herein provided for paving or repaving with macadam, or oil-macadam.

Resetting of stakes disturbed or destroyed by the contractor shall be at the expense of said contractor.

(F) Upon street work under the general street laws of the state of California, the cost of which is to be paid by a district assessment, the fee shall be 5% of the cost of construction.

FEES FOR THE FOLLOWING FIELD OR OFFICE WORK shall be as follows:

For such miscellaneous engineering, surveying or drafting work not specifically covered, the fees to be charged shall be at the rate of $20 per day for each field party of three men, and $8 per day for each office man.

For copies, additional to those required by Section 1 of this ordinance, of survey diagrams or street-work certificates, $1 for each copy.

For blueprint copies, additional to those required by Section 1 of this ordinance, of such tracings or negatives of maps, street improvement plans, assessment diagrams, etc., as are part of the office records of the City Engineer's office, 50c. for the first square foot of each of said copies and 5c. for each additional square foot thereof; no copy to cost less than 50c. and no blueprints to be made from other than office records.

For plans and specifications of work for which the City Council, or other authorized municipal body, is asking for bids, the City Engineer is hereby authorized to collect from prospective bidders on said work, the sum of $5 for each set of plans and specifications. For a period of 30 days after the time fixed for receiving bids on the work, the said sum of $5 shall be considered merely as a deposit; in case the plans and specifications are not returned within the 30-day period, then they shall become the property of the holder thereof and the $5 held by the city shall be considered as payment therefor.

In order for an engineer in private practice to compare, or gage, his charges by the foregoing, it is essential to know the salaries paid the Oakland city engineering staff. These are as follows: One Deputy City Engineer, $3000 per annum; four Assistant Engineers, $1980 to $2400; three Office Engineers, $1620 to $1920; one Field Engineer, $1620 to $1920; one Junior Engineer, $1680; four Instrumentmen, $1500; two Instrumentmen, $5 per diem; 14 Draftsmen, $1320 to $1500 per annum; one Assistant Draftsman, $840; ten Chainmen, $900 to $1080; four Chainmen at $3 per diem; besides, of course, the clerical help of a bookkeeper, stenographer and clerk, at a combined salary of $3180 to $4080.

A Floating Caisson for Capping Subaqueous Piles

By John Taylor*

A common type of dock wall is built with a substructure of round piles driven in bents at varying centers and depths to suit local conditions and cut off about two feet below extreme low-water level to prevent decay through exposure to air. The piles are then capped with heavy cross and longitudinal timbers bolted to them, the bents being also generally further strengthened by cross-bracing placed on the piles between the capping and the ground line. This substructure usually carries a superstructure of block and masswork concrete, cellular spaces being left between the pile bents, the whole being bridged over at the dock level by a concrete deck usually reinforced by steel girders or rods. Steel or wood piling is driven either in front or at the rear of the wall to support the fill placed behind it. This type of construction appears in various modified forms, and is found in most ports of the Great Lakes and is very generally used by the U. S. Engineer Corps and also by the Canadian Government on harbor work and elsewhere.

Viewed superficially, the idea of a braced pile substructure appears to be at first glance a cheap and easy solution of underwater dock-wall construction where the strata are such that piles can be driven. In actual practice, however, a variety of constructional difficulties in connection with the underwater portion adds materially to the cost, placing a high unit price on the materials used in that part of the work.

One of the greatest troubles is the work of aligning the pile bents under water and the placing of the cross-bracing and longitudinal timbers between the water surface and a few feet below. Here a diver is easily affected by weather conditions, and the shallow water makes the work in the heavy helmet equipment arduous and extremely slow and costly. Where the water is polluted or riled it is made increasingly difficult. It is almost impossible under ordinary conditions to drive piling in bents absolutely accurately in line and position under water, and where a superstructure of blockwork or piling has to be made to fit in with this part of the work it renders necessary the use of heavy clamps, jacks and other devices to force the piles into alignment and attach the timber capping. When the piling has been once properly aligned the placing of the lower bracing and longitudinals is comparatively easily done. To do most of this work by divers is a tedious and expensive operation.

In constructing a wharf wall some 1600 ft. long at Hamilton, Ont., Harbor, for the Canadian Government at a location where a near-by sewage-disposal plant darkens and dirties the water, the writer has designed and used successfully a floating compressed-air working caisson for subaqueous construction which has overcome the above noted difficulties with this timber pile and girder form of sea-wall construction. It is essentially an improvement or adaptation of the familiar diving bell.

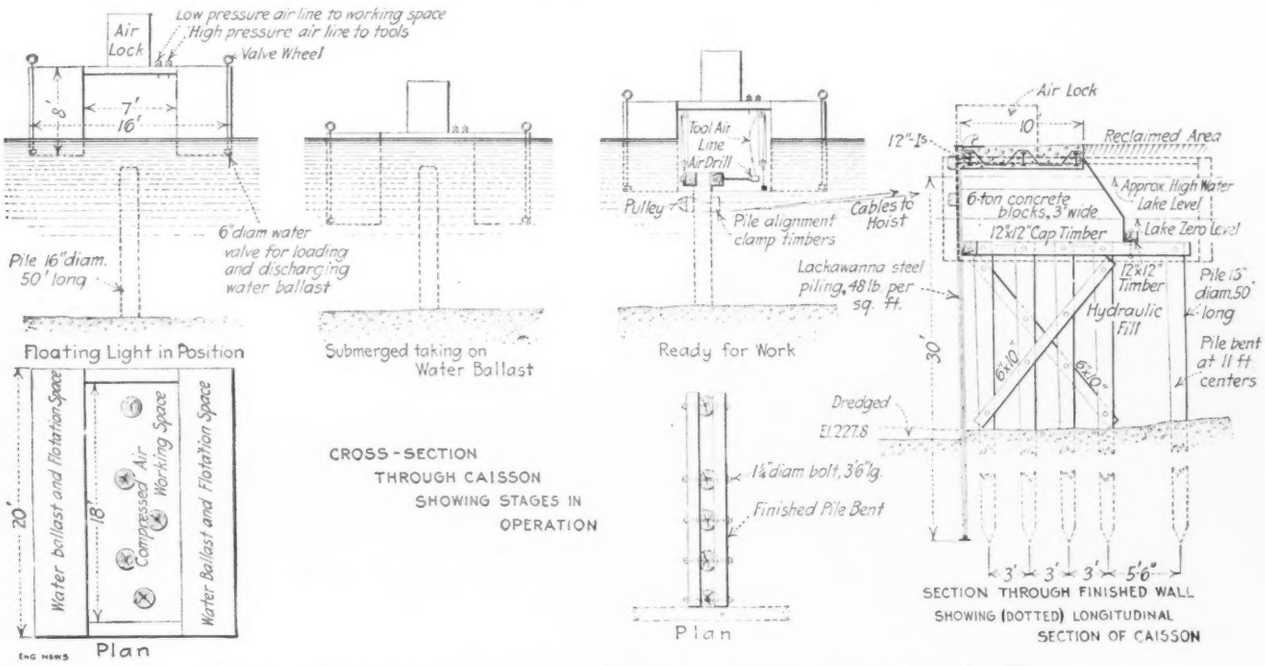


Fig. 1. Details of Operation of Caisson in Capping Piles for Sea Wall

The quay wall, at Hamilton, consists of a continuous concrete and steel slab supported on concrete blocks, 3 ft. wide (parallel to the lake front) and spaced 11 ft. c. to c., each block being in effect the cap for five transverse wooden piles cut off some 2 ft. below lake zero level. The face of the wall is continuous steel sheet piling, and the area back of the wall is to be filled in, the fill tailing down under the concrete superstructure and up against the steel sheet piling. A section through the wall is shown at the right in Fig. 1.

Compressed-Air Caisson

Fig. 1 shows progressively the operation of the caisson used in capping the piles for the Hamilton wall. At the left, the caisson is floating above the transverse line of

*Supt. of Construction, Ottawa Contractors, Ltd., Hamilton, Ont.

piles, which are to be capped as a bent. These piles are driven down by a floating piledriver to at least 2 ft. below the water level, enough being left above grade to finish and trim down to the required —3 elevation. The caisson is floated into position and securely moored.

The 6-in. water-ballast loading and discharging valves are then opened, admitting the water into the water-ballast tanks which form a part of the structure. The whole apparatus is then submerged in a few minutes into the second position in Fig. 1, the imprisoned air having been allowed to escape through the valves from the ballast spaces and also the working space.

The ballast tanks are thus filled with water and the water valves are then closed. The air valves are also at the same time closed preventing the apparatus from being submerged any further. The working space then surrounds the work to be done. Air is now admitted from the compressor plant to the working space through the life air-supply pipe. This air being imprisoned in the inverted box forming the working space depresses the water down to the lower edge of the ballast tanks when the excess pressure naturally escapes from under the lower lip and maintains the water at that level. The ballast tanks meantime elevate the water imprisoned in them to a level above the outside water level. The water elevated by this means plus the dead weight of the apparatus provides sufficient ballast to counteract the upward thrust of the air compressed against the roof inside the working space.

The water depressed inside the working chamber is, of course, equal in weight to the entire load available for ballast. For deeper working up to the capacity of its depth the apparatus can be further permanently loaded by placing iron weights or other suitable material inside the ballast tanks, thus keeping it at a lower level relative to the water surface.

Construction of Caisson—The working chamber is 7x18 ft. in plan and 7 ft. high inside. In this work the pile bents are spaced at 11-ft. centers and measure 16 ft. overall across the wall. One pile bent at a time is covered by the caisson. The maximum depth to which the water is required to be depressed in order to give clear access for placing the cross timbers and longitudinals in the dry is 3 ft. below zero level of Lake Ontario.

The framework of the chamber consists of 4x6-in. beams of white pine with cross bracing and longitudinals in the ballast tanks and A-trusses on top and bottom of the tanks to stiffen the framing, all securely bolted with

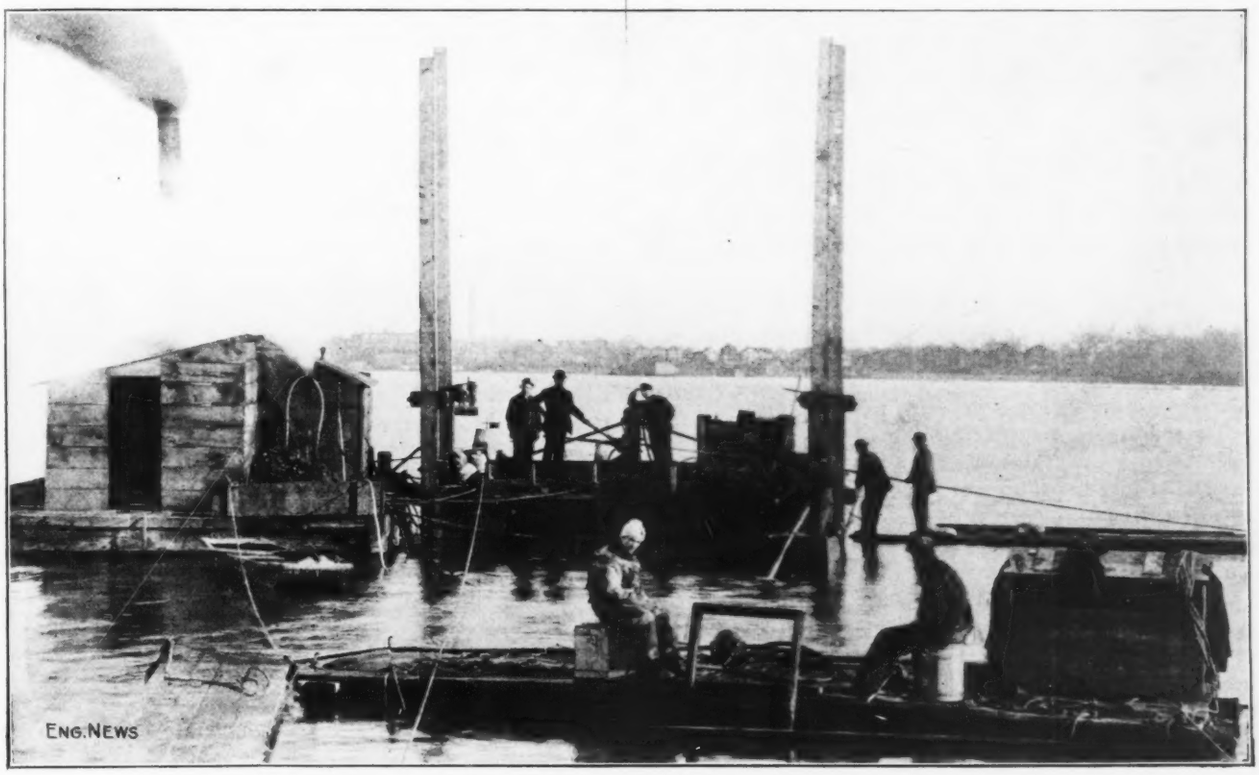


Fig. 2. View of Caisson Working in Hamilton Harbor

⅝-in. bolts. The top and bottom end timbers are of 6x10-in. douglas fir. Across the top of the air chamber, and running longitudinally a 10x12-in. timber of douglas fir is placed to take the upward air pressure on the center of the roof of the caisson. The ends of this beam are tied down through the end 6x10-in. timbers with 1½-in. tie-rods and an A-frame truss is placed with these rods as tension members on the ends of the air chamber.

The water-ballast tanks and air chamber are built of specially well dried seasoned white pine. The tongued-and-grooved joints of the 2-in. planking are filled with a thick solution of asphalt which was chosen on account of its elastic properties and the whole apparatus is painted with the same material. The outside exposed ends of the air chamber are double sheeted with 2-in. planking tongued-and-grooved.

The inside of the walls and roof of the working chamber are lined with heavy galvanized iron, all joints and

nail heads being heavily soldered to prevent air leakage. Horizontal fenders to protect this lining are placed around the inner sides and edges of the chamber. On each of the four outside corners are placed spuds of 10x10-in. timber 32 ft. long. These are raised and lowered by wire cables running from a hand-operated capstan placed on the center roof beam. These spuds, if desired, are provided as anchorages and as a protection against possible breakdown of the air supply, and are intended to be dropped immediately should this occur. They are not, however, vitally necessary to the successful operation of the apparatus as a whole.

Access is provided to the working chamber by means of an air-lock placed in the roof of the working space. The doors of the lock are of wood of heavy construction with heavy hinges and a clamping arrangement. The hinges are set so as to bring an even pressure over the whole bearing surface of the doors. The meeting surfaces are mitered and provided with rubber bearing surfaces to give an air-tight joint. This makes a simple and effective airlock.

Four ½-in. air valves are provided for controlling the lock which can be operated, two from the inside of the lock, one from the working chamber and one from the outside. A steel lock of the usual type can, of course, be used.

The working platform is suspended by ½-in. dia. manila rope from sets of double and single blocks. The platform frame is made the full size of the chamber and is fitted with loose removable planks forming the platform. Working equipment such as clips to hoist the timbers to be framed up are suspended by ropes on blocks from eyebolts and rods on the roof of the working chamber and suspended tool boxes are provded. All tools are secured by a light line to prevent their being accidentally dropped in the water and lost through the open bottom of the caisson.

A telephone is provided, the instrument on the inside being removable to prevent it being damaged by water when the caisson is sunk, and the cells are placed in a water-proof instrument box on the outside wall of the air lock. A separate high-pressure air connection is provided for an air wood-drill and saw inside.

A water-gage glass, with cutoff valves which can be closed in case of glass breakage, communicates with the water outside and allows the exterior water level to be read inside, and when the reading is obtained from the dock water gage the level can be transferred very closely for setting out the construction inside the working space. A large scale low-pressure air gage on the roof graduated to ounces shows at a glance the air pressure in the caisson.

On the four outside faces of the caisson, gage boards, graduated to inches, show the level to which the lower edge of the working space is depressed below the outside water surface. To provide light, two small windows, double, of heavy wired glass, protected by gratings, are fitted in the roof in rubber seats, but on dull days ordinary lamps are used to light the working space.

At Hamilton, the depth to which the water is depressed inside the working space does not exceed 6 ft. and as 1 lb. superatmospheric pressure will depress water approximately 2 ft. the pressure under which the men work does not exceed 3 lb. per sq.in. for 6 ft. depression.

To empty the water-ballast tanks, it is only necessary to open the 6-in. diam. water valves and retain the air in the working chamber when the ballast tanks will discharge their load and the apparatus again rise in a few minutes into the position shown in Fig. 1, the valves being then closed. In order to completely expel the water from the ballast tanks, the air valves communicating with the working space admit air to the tanks which forces the remainder of the water through the 6-in. water valves. This can be done to obtain a specially light draft, and with the tanks unloaded thus, the light draft does not exceed 1 ft. 6 in. in the machine described.

The air supply is provided by compressor capable of delivering 100 cu.ft. of free air per minute, placed on a separate scow moored alongside, steam being supplied by a 30-hp. boiler also placed on the scow. This compressor also supplies air to the one diver necessary on the work who follows behind doing incidental work of any kind.

Air lines of ¾-in. diameter rubber hose run from the storage tanks; one supplies low-pressure air for the working chamber and the other high-pressure air for a wood-drill which is used on all boring for bolts in the timber wor. These air lines are attached to the roof of the working space.

The high-pressure line supplies air at 95 lb. per sq.in., while the low-pressure line supplies air for the working space, cut down by an air-reducing valve to a little above the actual pressure required. This surplus pressure is allowed to blow off through a safety escape valve in the roof to purify the air, and it also makes good any air leakage. Of course, as soon as the air pressure rises too high, on account of the exhaust from the air tools, it blows off under the lower lip of the working chamber and thus automatically regulates the water level inside the working space.

In the event of a serious breakdown of the air compressor or piping, instructions are given to the operator and his assistant outside to immediately open the water-ballast tank valves and allow the ballast to discharge and drop the spuds, meanwhile to lock out the men in the working chamber, but this has never been necessary. There is ample storage in the air tank and working chamber to allow of this being done before the water level begins to rise in the inside, this having been tested previous to use. Being built almost entirely of wood, the caisson cannot sink altogether and a man can always dive under the lower lip if necessary. Fortunately, so far not the slightest mishap has occurred in the operation.

Aligning Piles—Anyone with experience in driving long round wood piling, particularly under water, will readily understand that it can rarely be driven in perfect position and alignment. Even if the piles are set out and started in the exact location they will creep out of the vertical, and the best of judgment on the part of the man who heads and points a slightly bent but otherwise perfect pile will not prevent it from getting out of position to some extent in driving.

In order to overcome this difficulty the writer uses ratchet pulling and pushing jacks to align the piles in position transverse to the face of the wall. To align the piles lengthwise of the bent two heavy timbers are sunk as shown in the third position in Fig. 1, alongside the piles and are suspended at a depth clear of any work to be done. Two steel-wire cables lead from a hoisting engine

placed at any convenient point on the line of the wall at some distance away. These run round a pulley on the farther side and return and are connected by eye-bolts to the nearer timber. When the hoist tightens these cables, it pulls the top of the piles into line ready for work and holds them there while the piles are trimmed and the permanent cross timbers bolted up.

Results Attained—The apparatus can be operated almost in any weather, with the exception, of course, of rough water and excessively severe cold. It has been worked in zero weather with comparatively little inconvenience as the water is kept from freezing in the ballast tanks by the air, which naturally is warm. The exhaust steam from the compressor can be used to prevent freezing if desired.

It has been found that work can be done very satisfactorily in the ice simply by cutting ahead the necessary space to move, each day, and this has the advantage that seas do not affect the working in any way. The ice provides an excellent working space all round for framing timbers, previous to passing them down under the apparatus to the men.

The caisson requires three men inside, one engineer and fireman outside and an attendant who brings supplies, etc., as required.

So far, in three months' operation, including preliminary starting of the machine, it has completed about 400 ft. run of the underwater work of the wharf wall being built. If divers had been necessary at least six with their attendants would have been required to do the work in the same time, and the compressed-air equipment and hoist would also have been in any case required for them to supply air for tools and pull the piles into position. Divers would have been more susceptible to bad weather and must have lost a great deal of time as there would have been days when they could not work at all. On such days this caisson operated quite easily as the men were quite dry and warm inside and the attendant scow, being housed in, protects the men outside.

In such work, time is generally the primary consideration as the rest of the work is held back until this part is completed. In the Hamilton work, the wall superstructure and retaining steel pile facing cannot be placed in position in the wall until the underwater work is done and consequently the fill could not be placed behind the wall, which in turn holds up the carrying out of the dredging from which the fill is obtained. Delay on the finishing up of the underwater timberwork causes a general tie-up on the construction.

By the use of this apparatus, however, the work is reduced to a more business basis independent of the vagaries and caprice of divers. To anyone who has had charge of any extensive diving operations this point will be very readily understood and appreciated.

Personnel

The apparatus is the invention of the writer who is a Director of, and Superintendent of, the Ottawa Contractors, Ltd., who are carrying out the work. This consists of the building of a wharf wall 1600 ft. long, and the reclamation of several acres of shallow water area on the city water front for the Hamilton Harbor Commission, the work being done directly by the Dominion Government. The view in Fig. 2 shows the caisson operating in the harbor.

Stream-Flow Studies

By Edward H. Sargent*

The following outline of some methods used in making stream-flow studies is the result of seven years study of the streams of New York State by the engineers of the State Water Supply Commission and its successor, the Conservation Commission. It was written for the benefit of the engineers of these Commissions and is presented here in the hope that it may be useful to the profession at large. Some of the methods given here are not original but it is believed that the procedure in making stream-flow studies has been amplified at least beyond what is given in the college curriculum.

Location of Data—Nearly all of the stream-flow data on New York streams can be found in the annual reports of the Conservation Commission, the State Water Supply Commission (previous to 1911), the State Engineer and Surveyor, the Board of Water Supply of City of New York, and in the U. S. Geological Survey Water Supply papers. Rainfall and temperature records are published in the monthly and annual reports of the U. S. Weather Bureau. Many valuable statistics are also to be found in "Hydrology of the State of New York" by George W. Rafter.

Mass-Curve Studies—Some phases of a given stream flow can best be studied by the Mass-curve method. The method consists in adding up the totals of the yield in monthly or daily increments from month to month, for the whole period of gagings under consideration; then plotting these totals as ordinates with the corresponding time as abscissas to form the mass curve.* Any desired curve of draft may then be assumed, and plotted to the same scale. If a uniform rate is assumed, this draft curve forms a straight inclined line, and if it is made to start coincident with some point or summit on the mass curve, the divergence of the two curves at the end of any dry period serves to show the volume of storage that would have been required to have maintained the assumed draft up to that time. Conversely, any volume of storage may be assumed and plotted as an ordinate at the point on the mass curve at the end of the dry season, and the slope of the line drawn from the previous peak of the mass curve to this ordinate will give the regulated flow possible by the use of this volume of storage.

The records giving the mean monthly flow in second-feet are converted into cubic feet per month, by multiplying by the factor, 2,628,000, which is the number of seconds in an average month, i.e., a month of $\frac{365}{12} = 30.42$ days.

The results of river regulation with a given storage reservoir will not be the same at widely separated points below the reservoir, particularly if the flow of the river has been materially augmented by the entrance of streams between these points. Each point will require a different method of operation of the reservoir to give the best result at that point.

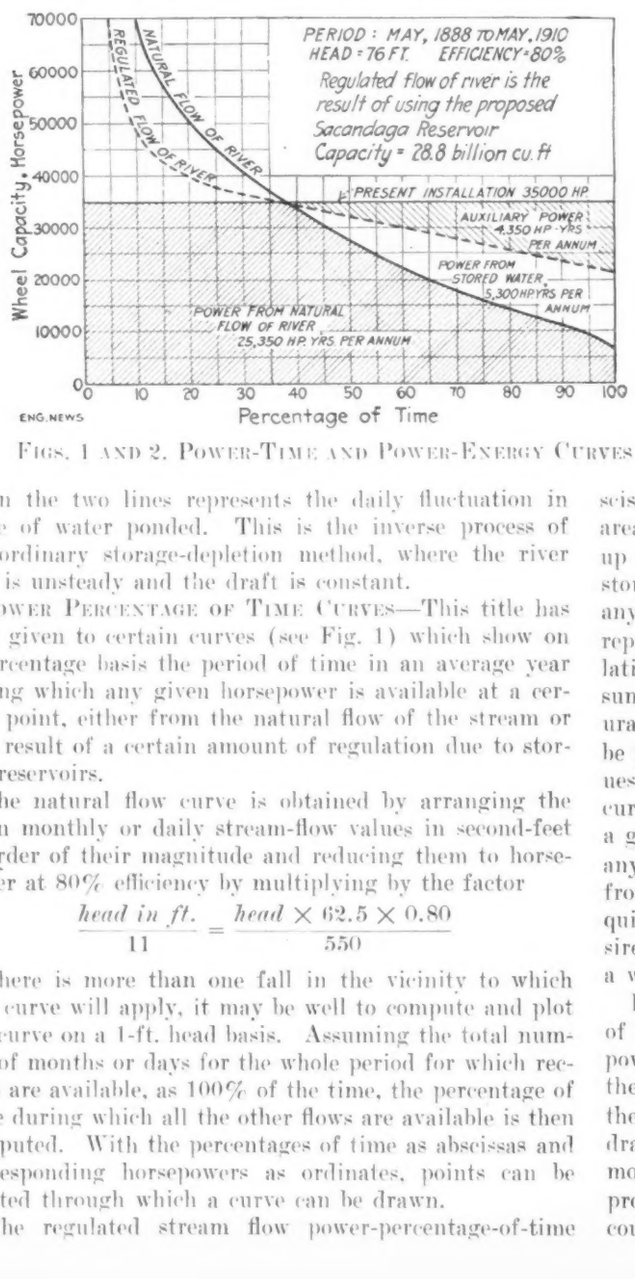
The mass curve offers an easy method by which to determine the respective effects on the flow of the river at these more or less remote points, by release of the stored water in a prescribed manner. This is accomplished by plotting separate mass curves for the different points

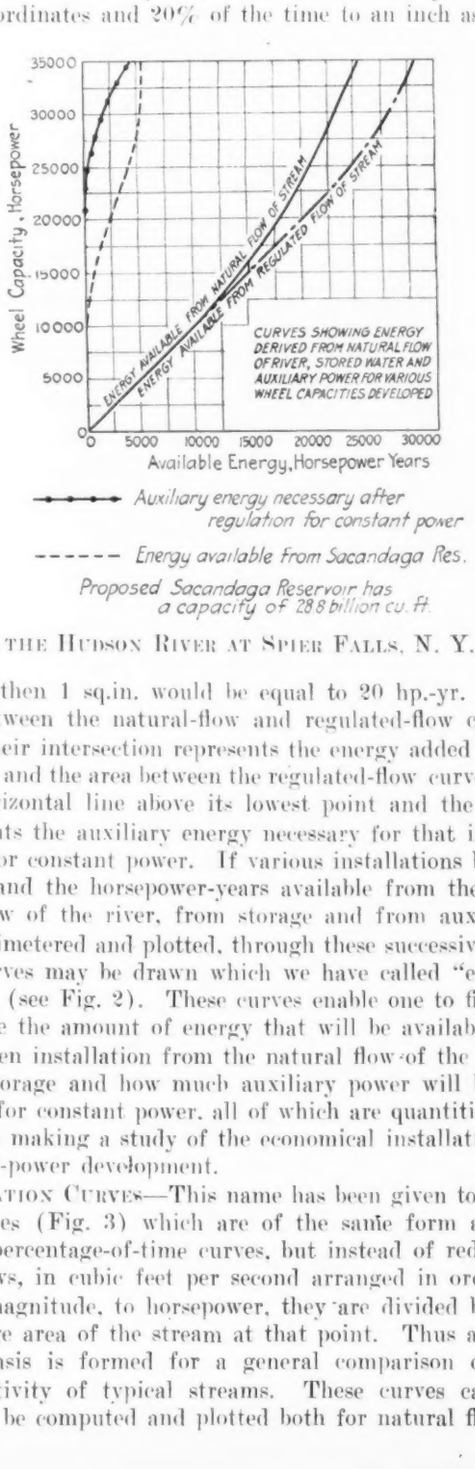
*Assistant Engineer, New York State Conservation Commission, Albany, N. Y.

*Various mass-curve studies have been described in "Engineering News," Sept. 11, and Dec. 25, 1913.—Ed.

under consideration. Any point may be chosen as the one for which the best regulation is desired at the expense, to some extent, of the other places. The proposed draft line may then be drawn on the mass curve for this point, bearing in mind that the maximum ordinate-intercept must not exceed the reservoir capacity. Having done this the incidental effect upon the flow at each of the other points may be readily found by superimposing these ordinate-intercepts on each of the other mass curves, thus making up new mass curves which represent the new flow of the river due to the presence of the regulating reservoir.

This method has also proved efficient for determining the amount of pondage necessary to regulate for the unequal hourly draft due to a load factor of less than 100%. A hydrograph is first made up from the load diagram, showing the mean hourly demand from the pond. These values are then integrated to make up a daily mass curve of draft. The steady river supply is represented by a straight line, and the maximum ordinate intercept between the two lines represents the daily fluctuation in value of water ponded. This is the inverse process of the ordinary storage-depletion method, where the river flow is unsteady and the draft is constant.


PERIOD: MAY, 1888 TO MAY, 1910
HEAD = 76 FT. EFFICIENCY = 80%
Regulated flow of river is the result of using the proposed Sacandaga Reservoir Capacity = 28.8 billion cu. ft
NATURAL FLOW OF RIVER
REGULATED FLOW OF RIVER
PRESENT INSTALLATION 35000 HP
AUXILIARY POWER 4,350 HP-YRS PER ANNUM
POWER FROM STORED WATER 5,300 HP-YRS PER ANNUM
POWER FROM NATURAL FLOW OF RIVER 25,350 HP-YRS PER ANNUM
Wheel Capacity, Horsepower
Percentage of Time
ENG. NEWS


Wheel Capacity, Horsepower
ENERGY AVAILABLE FROM NATURAL FLOW OF STREAM
ENERGY AVAILABLE FROM REGULATED FLOW OF STREAM
CURVES SHOWING ENERGY DERIVED FROM NATURAL FLOW OF RIVER, STORED WATER AND AUXILIARY POWER FOR VARIOUS WHEEL CAPACITIES DEVELOPED
Available Energy, Horsepower Years
Auxiliary energy necessary after regulation for constant power
Energy available from Sacandaga Res.
Proposed Sacandaga Reservoir has a capacity of 28.8 billion cu. ft.

FIGS. 1 AND 2. POWER-TIME AND POWER-ENERGY CURVES FOR THE HUDSON RIVER AT SPIER FALLS, N. Y.

POWER PERCENTAGE OF TIME CURVES—This title has been given to certain curves (see Fig. 1) which show on a percentage basis the period of time in an average year during which any given horsepower is available at a certain point, either from the natural flow of the stream or as a result of a certain amount of regulation due to storage reservoirs.

The natural flow curve is obtained by arranging the mean monthly or daily stream-flow values in second-feet in order of their magnitude and reducing them to horsepower at 80% efficiency by multiplying by the factor

$$\frac{head\ in\ ft.}{11} = \frac{head \times 62.5 \times 0.80}{550}$$

If there is more than one fall in the vicinity to which this curve will apply, it may be well to compute and plot the curve on a 1-ft. head basis. Assuming the total number of months or days for the whole period for which records are available, as 100% of the time, the percentage of time during which all the other flows are available is then computed. With the percentages of time as abscissas and corresponding horsepowers as ordinates, points can be plotted through which a curve can be drawn.

The regulated stream flow power-percentage-of-time curve is obtained in the same manner by substituting for the natural stream flows the regulated flows obtained from the mass curve for a given volume of storage during the months they are maintained, converting them into horsepower, computing the corresponding percentages of time, and plotting as in the previous case.

ENERGY CURVES—If the power-percentage-of-time curves for natural and regulated flow are plotted from the same set of axes (Fig. 2), the area between the natural-flow curve and the axes represents the amount of energy available from the natural flow of the stream. This area is reduced to horsepower-years as follows: Suppose the curves to be plotted to a scale of 100 hp. to the inch as ordinates and 20% of the time to an inch as abscissas, then 1 sq.in. would be equal to 20 hp.-yr. The area between the natural-flow and regulated-flow curves up to their intersection represents the energy added from storage, and the area between the regulated-flow curve and any horizontal line above its lowest point and the axis represents the auxiliary energy necessary for that installation for constant power. If various installations be assumed and the horsepower-years available from the natural flow of the river, from storage and from auxiliary be planimetered and plotted, through these successive values, curves may be drawn which we have called "energy curves" (see Fig. 2). These curves enable one to find at a glance the amount of energy that will be available for any given installation from the natural flow of the river, from storage and how much auxiliary power will be required for constant power, all of which are quantities desired in making a study of the economical installation of a water-power development.

DURATION CURVES—This name has been given to a set of curves (Fig. 3) which are of the same form as the power-percentage-of-time curves, but instead of reducing the flows, in cubic feet per second arranged in order of their magnitude, to horsepower, they are divided by the drainage area of the stream at that point. Thus a common basis is formed for a general comparison of the productivity of typical streams. These curves can, of course, be computed and plotted both for natural flow of

streams and for the regulated flow due to any amount of storage. The duration curve offers a simple solution of a quantity frequently desired, namely, the minimum

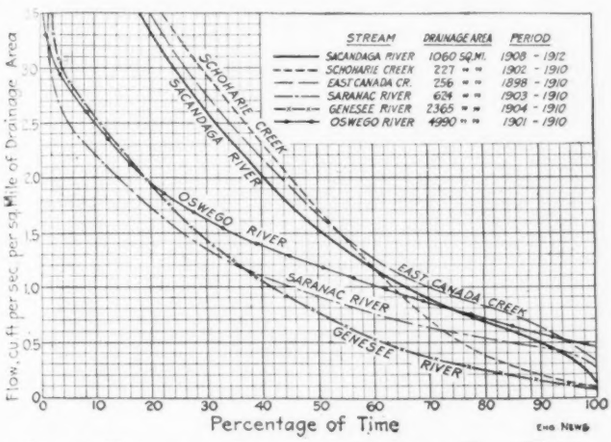

STREAM DRAINAGE AREA PERIOD
SACANDAGA RIVER 1060 SQ.MI. 1908 - 1912
SCHOHARIE CREEK 227 " " 1902 - 1910
EAST CANADA CR. 256 " " 1898 - 1910
SARANAC RIVER 624 " " 1903 - 1910
GENESEE RIVER 2365 " " 1904 - 1910
OSWEGO RIVER 4990 " " 1901 - 1910
SCHOHARIE CREEK
SACANDAGA RIVER
OSWEGO RIVER
SARANAC RIVER
EAST CANADA CREEK
GENESEE RIVER
Flow, cu ft per sec. per sq Mile of Drainage Area
Percentage of Time
Eng News

FIG. 3. DURATION CURVES OF TYPICAL NEW YORK STREAMS

monthly natural stream flow for an average year. This is secured in the following way: According to our hypothesis, the maximum abscissa of the curve is an average year, and a month in the average year would be 8.3% of the time; the flow available for the driest month of this average year would be shown by that part of the curve between 91.7% and 100% of the time. To secure the average monthly flow we should planimeter the area between 91.7% and 100% and divide it by 8.3%. We then have the mean monthly flow for the driest month. Frequently this part of the curve approximates a straight line and the mean of the flow available for 91.7% of the time and 100% of the time will be sufficiently accurate.

CHARACTERISTIC CURVES—This name has been given to a set of curves (Fig. 4) which show the maximum uniform flow, per square mile of drainage area, as obtained from the mass curve, which could have been maintained throughout a given period due to various quantities of storage per square mile of drainage area. For this purpose we should plot the regulated flow in second-feet per square mile of drainage area as abscissas, and the required storage in million cubic feet per square mile as ordinates.

By plotting the characteristic curves of several typical streams, we are able to compare their respective water values. These characteristic curves are instructive: (1) by showing the maximum uniform flow available on the respective streams if the yield of the watershed were to be completely conserved for regulating purposes by unlimited amounts of storage; (2) by indicating the limit of reasonable development of the watershed and the resulting maximum uniform flow. Thus assuming that there is no lack of storage opportunities which could be developed at a reasonable cost per million cubic feet of water stored, the economical point of development of this storage lies below the sharp upward turn of the curves, or where the storage requirement increases at a much faster rate than the rate of flow increases.

The above was not intended to be a discussion of all methods which can be used in making stream-flow studies; for example, nothing has been stated regarding the hydrograph which is extremely useful in the preparation of plates explaining to the lay mind the effect of storage in regulating stream flows but it is hoped that some procedures not well known have been outlined.

The water supply and water-power surveys, designs and

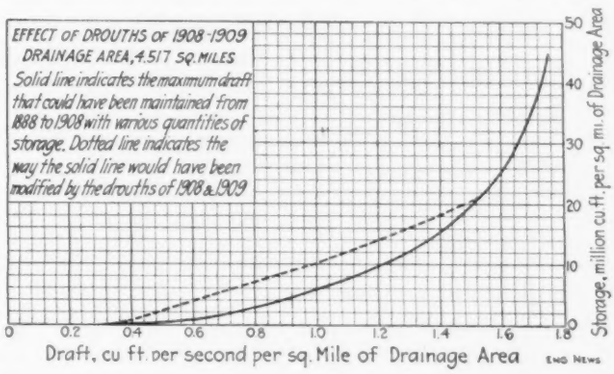

EFFECT OF DROUTHS OF 1908-1909
DRAINAGE AREA, 4,517 SQ. MILES
Solid line indicates the maximum draft that could have been maintained from 1888 to 1908 with various quantities of storage. Dotted line indicates the way the solid line would have been modified by the drouths of 1908 & 1909
Draft, cu ft per second per sq. Mile of Drainage Area
Storage, million cu ft. per sq. mi. of Drainage Area
Eng News

FIG. 4. CHARACTERISTIC CURVE OF HUDSON RIVER, AT MECHANICSVILLE, N. Y.

estimates of the New York State Conservation Commission are made by the Division of Inland Waters, John D. Moore, Commissioner; R. W. Sherman, Chief Engineer; A. H. Perkins, Division Engineer; Edward H. Sargent, Assistant Civil Engineer in Charge of Hydrography.

Tipples for Coal Mines*

BY ANDREWS ALLEN†

The connecting link between the mine and the top works is the tipple, through which the product is hoisted and prepared for the market. For a long-life mine the tipple should be of steel or some combination of steel and concrete. The requirements are: 1, strength against any possible service demands or accident, 2, resistance to the corrosion of shaft gases; and 3, convenience and accessibility.

Many mines have an "upcast" hoisting shaft; that is to say, the air to ventilate the mine is forced down the air shaft by means of a blowing fan, and comes up the hoisting shaft plus moisture, heat, powder-smoke and gases. This makes an ideal place for an "acceleration test" of corrosion. When the tipple is housed over, shaft and all, these gases fill the structure and in cold weather the moisture condenses and hangs in drops of dilute sulphuric acid all over the interior surface. The sheet-metal covering prevents proper attention to the steelwork, and when it rots away the framework is often too far gone for repair.

The writer is now replacing a steel tipple built in this style only ten years ago. The owner began to realize what was happening to his structure too late to save it by tearing off the lower covering and painting the steelwork. The design of a tipple must be such as to expose the least possible amount of steel to the corrosion of the shaft gases. Wherever steelwork must be exposed it should either be protected by concrete or be made easily replacable.

An A-frame tipple was designed by the writer about the same time, and erected within a few miles of the tipple we are now replacing. This structure is still giving excellent service and is showing practically no deterioration except in part of the horizontal bracing carrying the guides, which has been partially renewed.

Still more effectively protected from gases is the newer type with heavy vertical guide columns (the only members exposed to gases) encased in concrete. The horizontal bracing members are practically eliminated, and these are the parts that give the most trouble in other designs. The shaft is entirely open to the dumping platform.

It must be noted in connection with this new design that nearly all modern shafts are concrete-lined, to the rock at least, so that the shaft curbing is the best possible foundation for the structure. In the days when wood-lined shafts were used the tipple foundations were set as far from the shaft as possible, as in the "A-frame" tipples.

*Extract from a paper before the Western Society of Engineers, Chicago, Apr. 6, 1914.

†Allen & Garcia Co., Consulting Engineers, McCormick Building, Chicago.

Field and Office

Decay of Wood Posts Encased in Concrete

By Henry Blood*

The accompanying halftones, from photographs made by the Department of Public Works, for the Bureau of Buildings, show the condition of bottom sections cut from the basement posts of two adjoining buildings in Portland, Ore. Fig. 1 shows the general arrangement of the buildings, and sectional views of the posts at the basement floor.

The posts are Douglas fir, and have been in place about

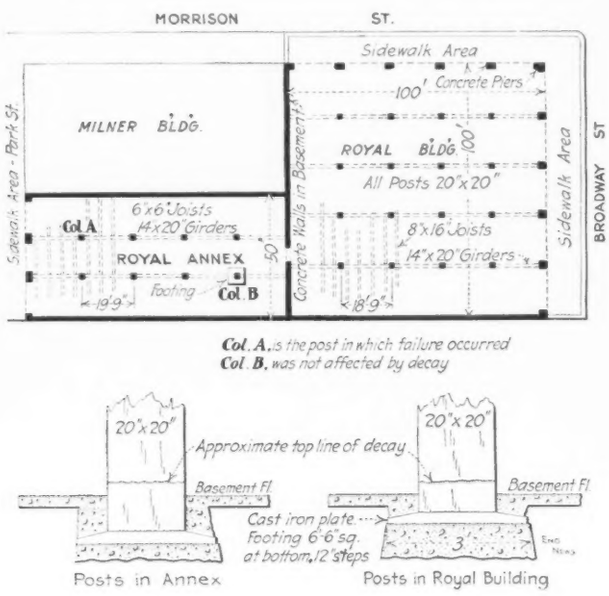


Fig. 1. Basement Plan of Two Buildings in Portland, Ore., and Sections of Wooden Posts Which Show Decay

seven years. In the Royal Bldg., they run from 4 to 5 in. below the top of the basement floor slab; in the Royal Annex from 9 to 10 in. They were surrounded by 6 to 8 in. of concrete in all cases. In the Royal Bldg., the concrete extended to the edge of base plates. The posts were not in contact with the earth at any point, so far as is known.

The cast-iron base plates are about 3 ft. square, 3 in. thick at the center, and tapered from the face of post. Footings are concrete. In the Annex, they are 3 ft. square at the top, 6 ft. 6 in. at the bottom, and 4 ft. deep, stepped off. Those in the Royal Bldg. are probably similar, as plans were made by the same architect and they were erected about the same time. All posts are nominally 20x20 in. On account of shrinkage and surfacing, they are actually but 19 or 19¼ in. each way. They have an 1½-in. hole bored lengthwise, and in the case of at least one post, a vent hole bored into this. As it was below the floor line, it did no good.

The Royal Bldg. is 100x100 ft., six stories high, with a mezzanine floor in one portion, and balconies in some of the stores. It has heavy brick walls; those on the two fronts being of pier construction, with five bays to the front. There are cast-iron columns under the piers in the first story, except at the corner, where a steel column is used. With the exception of some scattered offices and studios, it is occupied by light stores and manufacturing establishments. The Royal Annex is connected to it through the basement, and by corridors on each floor. It is 50x100 ft., six stories high, and has brick bearing walls. The occupancy is similar, except on the fifth and sixth floors, which are used for club and lodge rooms, respectively. Both buildings have interior framing of wood, the timbers being of large, or "mill construction" sizes. Posts have heavy cast-iron caps. There are eight posts in the Annex, and 16 in the Royal Bldg. Those in the Annex stop at the sixth floor, and the roof is carried by wood trusses exposed above it. First-floor girders are 14x20-in., the joists in the Annex 6x16 in. generally, and in the Royal Bldg. 8x16 in. Framing around elevator shafts and stair openings is special.

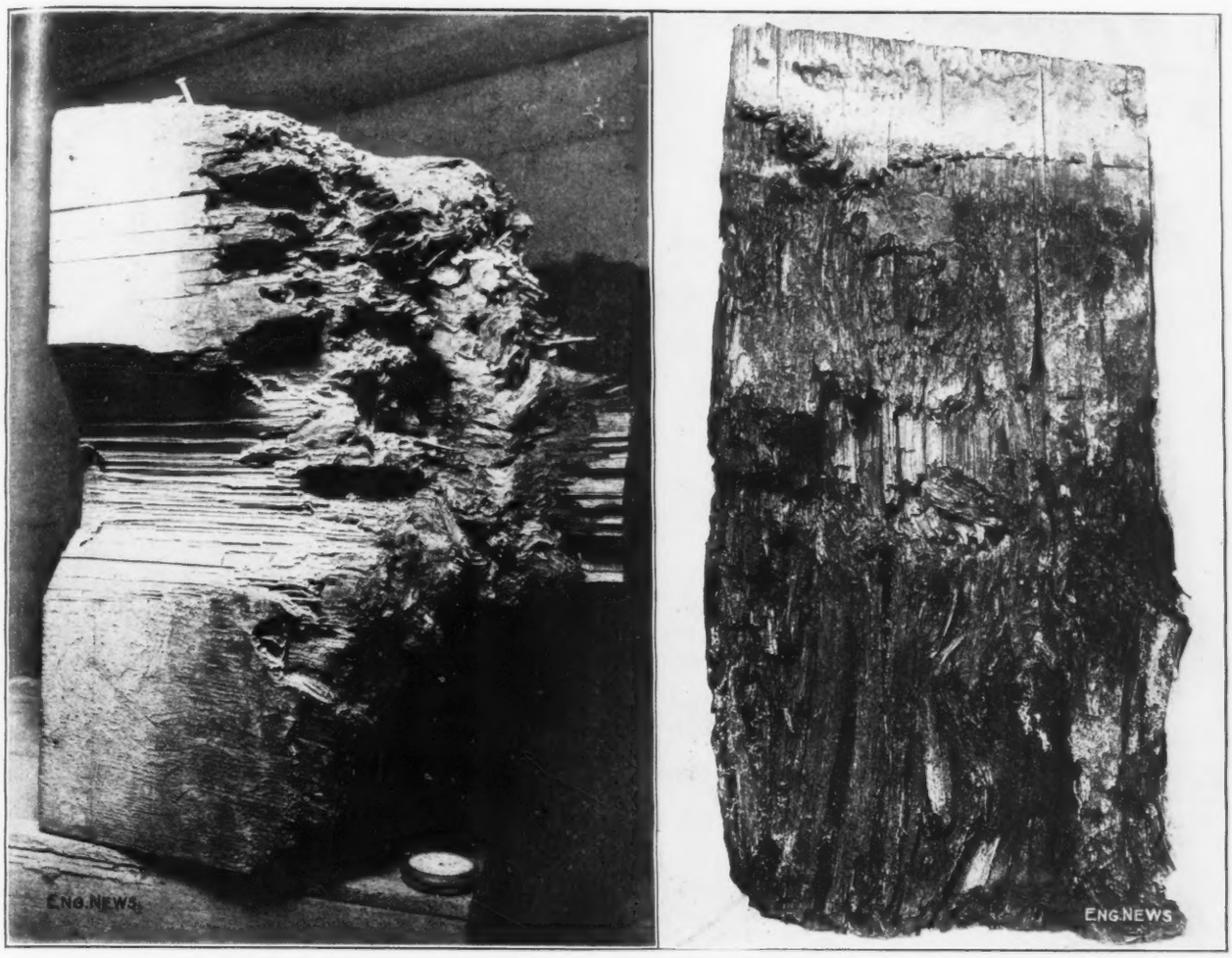
The basement of the Annex contains the heating plant for both buildings, fuel storage and some other small storage space. That of the Royal Bldg. contains a pool room, barber shop, small machine shop, and dry goods storage for stores above.

Soil at this point is sandy clay. There is good drainage toward the river, and the elevation of the lowest part of the basement floor is 25 ft. above usual high water. No special reason for dampness exists either in the soil or the use of the basement.

Settling of the floors was noticed for some time, and some of the partitions and plastered ceilings have bad

Fig. 2. Post "A" (Fig. 1.) in Place in the Building

*Structural Engineer, Bureau of Buildings, Portland, Ore.



FIGS. 3-4. VIEWS OF DECAYED POSTS AFTER REMOVAL FROM BUILDING

cracks. Two months ago, when a crowd of 800 persons was on the sixth floor of the Annex, it settled approximately 2 in. over one of the front posts, marked "*A*" in the sketch (Fig. 1). This started an investigation, and it was found that the post had crushed at the bottom. It extended 9 in. below the floor line, and the concrete prevented sudden crushing. The total settlement is stated by the contractor to have been nearly 4 in.

After repairing this post it was thought wise to examine the others and repair them, if found affected. Nearly all have been exposed up to the present date, and all except one were found decayed at the bottom. The decay in most cases extended 6 or 7 in. above the floor line. Posts in the pool room were not so badly decayed as in the corridors and storage space. The posts are painted and in general showed no outside indication of decay, but a crowbar could be readily thrust into them at the floor line, and pieces pulled away with the fingers after they were exposed. The post not appreciably affected is close to the top of the boiler-pit retaining-wall, and is exposed to almost constant heat and circulation of air. It is marked "*B*" on the plan.

The posts are repaired by supporting them on steel beams and jack screws while the bottom is sawed off from 6 to 10 in. above the floor line, depending on its condition. A small base-plate is put directly under the post, the present plate raised and bedded in grout, the space between the two plates filled with small plates under the center of post, and concrete placed around them. The plate fills are used so that it will not be necessary to leave shores until the concrete sets sufficiently.

The total dead-load on post "*A*," including weight of post and cast-iron caps, is 44,100 lb. The estimated live-load at the time of observed crushing, allowing 12 lb. per sq.ft. on the first and second floors, 10 on the third, fourth and fifth, and 40 on the sixth, was 29,100, a total of 73,200 lb. The area of post is 370 sq.in., giving a pressure of 198 lb. per sq.in. The loads on posts in the Royal Bldg. range from 117,000 lb. on interior posts with a floor area of 355 sq.ft. to 138,000 lb. on ones in outer rows carrying 380 sq.ft. The unit pressure is 316 and 373 lb. per sq.ft., respectively.

No one appears to know why the posts were set lower than the basement floor, but the architect has an explanation that the contractor had considerable dirt left from excavating, and rather than have it hauled away he had it spread over the basement floor, thus raising the grade several inches above that shown on the architect's plans.

It is believed that no further decay will take place. The plates under posts will prevent transfer of moisture through the concrete to the wood.

Probably there are other buildings of wood construction in the same condition. Posts should always stop at least slightly above the basement floor line, and should have a metal plate even if the load is small.

Surveying an Irregular Coal-Pile

By C. J. Barton*

The coal-pile in question was one of seven or eight hundred tons of pea anthracite coal. It was very irregular in shape, varying in depth from 4 to 12 ft. The ground beneath the pile was as irregular as the top of the coal. The writer was able to secure quite accurate measurement of the pile by following the method described below.

A ¼-in. gas-pipe was sharpened at the lower end by welding in a small piece of iron rod. The pipe was a little over 12 ft. in length, with marks to designate feet and half feet from the pointed end up. It was used to prod the coal at intervals of about 10 ft., to determine the actual depth of the bed at that point. The readings of feet and estimated tenths of feet were recorded in a notebook at each prodding of the coal pile.

A transit was used to run the several parallel north-and-south lines of stakes at which these gagings were made. As soon as one line of stakes was set, the instrument-man and the chainman went down the line prodding the pile at every stake, then proceeding to stake out and prod the line parallel to this one in a like manner. When all the depth readings had been taken along all of the parallel sections the volume was easily found, as the pile was now divided into a large number of rectangular portions whose volumes total to the volume of the whole pile. The volume of each rectangular portion was very closely approximated by multiplying the average height of the four corners by 100 sq.ft., the horizontal cross-sectional area of a single rectangular portion. To get the number of tons of coal from the number of cubic feet, a known volume of the coal was weighed, and from this the number of cubic feet per ton figured.† Dividing the total number of cubic feet in the coal pile by the number of cubic feet in one ton of coal gave the total number of tons of coal in the pile.

*1704 Sunnyside Ave., Chicago, Ill.

†The number of cubic feet per 2000 lb. ranges from about 32 to 40, depending on the mine and the size. To get weight from volume, therefore, a sample of the coal must be weighed. —Editor.

Collapsible Bridges for Philippine Rivers

In the Philippine Islands, there are a number of streams carrying just enough water to be unfordable, and subject to floods of extreme height and force which carry down large quantities of brush and trees. It is necessary to provide some crossing for these streams, and yet money is not available for the construction of a structure permanent enough to withstand the extreme flood conditions. To suit the circumstances, the Bureau of Public Works has designed a standard so called "collapsible" bridge which has been built in a number of locations. This bridge is essentially a series of pile timber bents, carrying short-span timber girders and floor, which are attached to cables reaching to deadmen on the shore. In general, the girder and floor system is broken in the middle of the bridge and the cables extend from either side of the river to a point midway. During a flood the floor and girder are torn from their insecure fastening to the bent and swing downstream, attached to the cables. After the flood has passed, the floor system is floated upstream and placed again upon the timber bents.

The accompanying views are of the collapsible bridge recently built at Gapan across the Penarañda River. The views are taken from the Quarterly Bulletin of the Bureau of Public Works in Philippine Islands for January, 1914, together with the description from which the cross-section given in Fig. 2 has been made up.

The Penarañda River has a flood width of 1640 ft., but its low-water width is somewhat under 300 ft. The bridge constructed for the site is 320 ft. long and is composed of sixteen 20-ft. spans. The width between guard rails is 7 ft. 2 in., which permits a 2-ft. 6-in. center walk and a wheel tread of from 3 ft. 2 in. to 7 ft. 2 in. The cross-section in Fig. 3 shows the construction. The bents each consist of three piles that are capped with 12x12-in. timbers, drift-bolted onto the pile heads. On these timbers rest longitudinal stringers on either side made up of two 10x10-in. and one 8x10-in. timber 20 ft. long. The 8x10-in. timber is capped with a 2x10-in. plank of heavier wood for the wearing surface of the wheels of normal gage. These stringers are bolted together but are not fastened to the bent. The intermediate roadway consists of 2x8-in. planks, transversely placed and

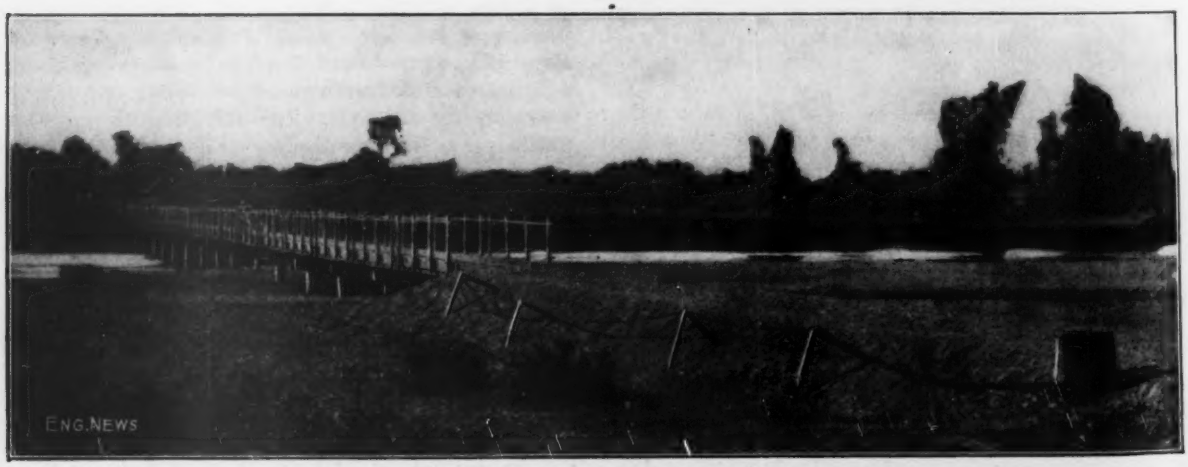


Fig. 1. The "Collapsible" Bridge across the Penaranda River, Gapan, P. I.

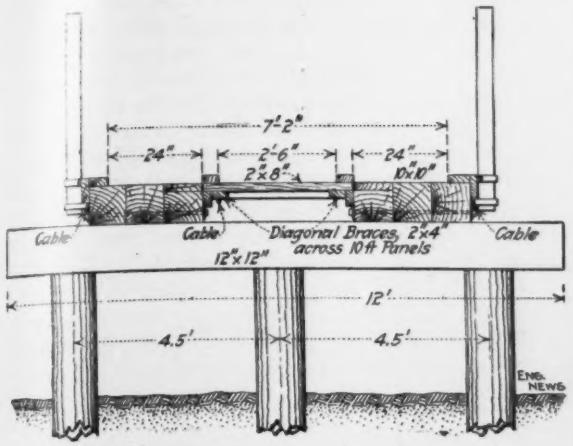


FIG. 2. SECTION THROUGH GAPAN BRIDGE

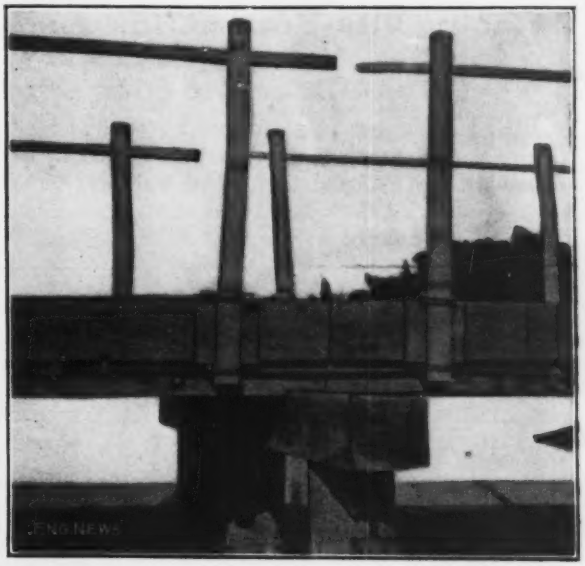


FIG. 3. VIEW OF FASCIA STRINGERS OF BRIDGE, SHOWING CABLE AND RAILING CONNECTIONS

resting on cleats spiked to the sides of the stringer timber. The intermediate roadway is in 10-ft. panel lengths held together by diagonal bracing underneath and by longitudinal battens above, these battens serving also as a guard rail for the wheels. The railing is of bamboo fastened to the outside guard planks by means of socket bands as shown.

The bridge is divided in half, with cables extending from each half to the deadmen on shore. Each half has three cables, one cable to each of the two stringer beams, and one cable to the center floor-panel system. The cable connections to the outside stringers are shown in the view in Fig. 3, which also illustrates the stringer seating, the railing connection, etc.

Capacity of Crane-Run Flanges of Mill-Building Columns

The table below, computed by Ernest Owen, Martin's Ferry, Ohio, applies to crane-girder columns in mill-buildings where the entire crane-girder load is carried on the inner flange. The common arrangement is to use a wide I-shaped column, cut back at the level of the crane-girder so that the upper section is a narrow I-section extended up to carry the roof framing. The front flange of the lower section carries the crane load. Here the two angles are reinforced by a channel riveted over them, flanges in. This channel adds sectional area and stiffens the column flange against transverse buckling. The capacity of the composite flange depends on the radius of gyration transverse to the column web-plate. In the other direction the web-plate provides ample stiffness.

The formula $p = 16{,}000 - 70\ l/r$, with maximum of 14,000 lb., was used. The load capacity is computed for lengths from 9 to 35 ft., for various combinations of angles and channels, such as are used in practice. The selection of sizes was so made as to give a fairly regular gradation of strength.

Only the two angles and the channel are counted as carrying the load; no allowance is made for the web-plate. This is the customary method.

CAPACITIES OF CRANE-RUN FLANGES OF MILL-BUILDING COLUMNS

Capacities in thousands of pounds, from formula p = 16,000 — 70 l/r; max. p = 14,000

(For column flange composed of two angles with a cover-channel. The column is assumed amply stiff in the direction of its web-plate. The web-plate is not counted as carrying any crane load.
Loads to right of short double lines are for values of l/r greater than 120).

Flange One channel	Flange Two angles	Area	Rad. of gyration	Unsupported length of column, ft. 9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
8"-11½	2L2½×2½	5.73	2.49	74	72	70	68	66	64	62	60	58	57	55	53	51	49	47	45	43	41	39	37							
"	2L2½×2½	6.29	2.40	81	78	76	74	72	70	68	65	63	61	59	57	55	52	50	48	46	43	41	39							
9"-13½	3x2½x½	6.51	2.86	87	85	83	81	79	77	75	73	72	70	68	66	64	62	60	58	56	54	53	51	49	47	45				
"	3x2½x½	7.13	2.75	95	92	90	88	86	83	81	79	77	75	73	71	68	66	64	62	60	57	55	53	51	49	47				
10"-15	3½x2½x½	7.34	3.20	100	98	96	94	92	90	88	86	84	82	81	79	77	75	73	71	69	67	65	63	61	60	58	56	54		
"	3½x2½x⅝	8.02	3.10	109	106	104	102	100	98	96	93	91	89	87	85	83	81	79	76	74	71	70	67	65	63	61	59	57		
"	3½x2½x½	8.68	3.02	117	115	112	110	108	105	103	100	98	95	93	91	88	86	84	81	79	76	74	71	69	66	64	62	59		
"	3½x2½x⅝	9.34	2.95	126	123	120	117	115	112	110	107	104	101	99	97	94	92	89	86	83	80	78	75	72	70	67	64	62		
12"-20½	4x3x⅝	10.21	3.73	143	140	138	136	134	131	129	127	124	122	120	118	115	113	111	108	106	104	102	99	97	95	92	90	87	85	83
"	4x3x½	10.99	3.65	153	150	148	145	143	140	138	135	133	130	128	125	123	120	118	115	113	110	107	105	103	100	97	95	92	89	87
"	4x3x⅝	11.77	3.56	163	160	158	155	152	149	147	144	141	138	136	133	130	127	124	122	119	116	113	110	108	105	102	99	97	94	91
12"-25	4x3x½	12.33	3.63	173	170	166	164	161	158	155	152	149	146	144	141	138	135	132	129	126	124	121	118	116	113	110	107	104	101	98
"	4x3x⅝	13.09	3.55	181	178	175	172	169	166	163	160	157	154	151	147	144	142	138	135	132	129	126	123	120	117	113	110	107	104	101
"	4x3x½	13.85	3.48	192	188	185	181	178	175	172	169	165	162	158	155	152	148	145	142	138	135	131	128	125	121	118	115	111	108	105
"	4x3x⅝	14.61	3.42	203	198	195	191	188	184	181	177	173	170	166	163	159	156	152	149	145	142	138	135	131	128	124	120	117	113	110
15"-33	5x3½x½	15.02	4.75	210	210	210	208	206	204	201	198	195	193	190	187	184	181	179	176	174	171	168	165	163	160	157	154	152	149	146
"	5x3½x⅝	16.00	4.65	224	224	224	221	218	215	212	210	207	204	201	198	195	193	190	187	184	181	178	175	172	169	166	163	161	158	155
"	5x3½x½	16.96	4.56	237	237	237	234	230	227	224	221	218	214	211	208	205	202	199	196	193	190	187	184	181	177	174	171	168	165	162
"	5x3½x⅝	17.90	4.47	250	250	250	246	243	240	236	232	229	226	222	219	216	212	209	206	202	199	196	192	189	186	181	178	175	172	168
"	6x6x½	18.62	4.46	261	261	260	256	253	249	245	242	238	235	231	228	225	220	217	214	210	207	204	200	196	193	189	186	183	179	176
"	6x4x½	19.40	4.50	271	271	271	267	263	260	256	252	249	245	242	238	234	230	226	223	220	216	212	208	204	201	196	193	190	186	183
"	6x6x⅝	20.02	4.37	281	281	278	274	270	267	263	260	255	252	248	244	240	236	232	228	224	220	216	213	209	205	201	197	193	189	185
"	6x4x⅝	20.52	4.43	287	287	284	281	278	274	270	265	262	259	254	250	247	243	239	235	231	227	223	220	216	212	207	203	199	196	192
"	6x6x½	21.40	4.28	300	300	296	292	288	284	280	275	271	267	263	259	254	250	246	242	238	234	229	225	221	217	212	208	204	200	196
"	6x6x⅝	22.78	4.20	318	318	314	310	305	300	296	291	287	282	278	273	268	263	259	254	250	246	241	237	232	227	223	219	314	209	204
15"-40	6x6x½	23.26	4.26	326	326	322	318	313	308	304	299	295	290	286	281	276	272	268	263	258	254	250	245	240	236	231	226	222	217	213
"	6x6x⅝	24.62	4.21	345	345	340	335	330	326	321	316	311	306	301	296	291	286	281	276	271	266	262	257	252	247	242	237	232	227	222
15"-45	6x6x½	26.12	4.21	365	365	360	355	350	345	340	334	329	324	318	313	308	303	297	292	287	282	277	271	266	261	256	250	245	240	235
"	6x6x⅝	27.46	4.16	385	385	380	374	368	364	358	352	346	341	336	330	324	319	313	308	303	297	292	286	280	275	270	264	258	255	248

Placing Pile-Foundation Piers for New Building before Demolition of Old

Driving piling for the piers of a 20-story building, in the cellar of the present structure before its removal, is something new in foundation work. This was done in the case of the new Mercantile Building which will occupy the site of the old Victoria Hotel (Fig. 1), at 27th St. and Fifth Ave. In order to have the offices of the new building rentable as soon as possible, it was decided to have the foundation piers ready when the old structure was removed. Ordinarily, the hotel would be torn down before starting work on the new foundations.

FIG. 1. THE VICTORIA HOTEL AT BROADWAY AND 27TH ST., WHEN THE PILE-DRIVING COMMENCED

Test borings showed water 3 ft. below the cellar floor so a sump pump was installed. The water was part of a subterranean stream flowing from Broadway and 27th St. to the East River at 17th St. After pumping from 300 to 500 gal. per minute for three weeks, the water level was lowered 6 ft. and the piling work was commenced.

The plan (Fig. 2) gives some idea of the extent of the job and with the photographs suggests some of its difficulties. The piers for the new building were not laid out with any regard to the walls and obstructions in the cellar of the Victoria Hotel. Of the 63 piers to be built, a party wall interfered with 5, an independent wall on the south side with 5, the exterior walls of the hotel with 21, and the cross-cellar walls with 14, leaving 18 located in the clear.

Bedrock occurred so near the boiler-room floor that it was necessary to blast in order to set the four grillages there, at the specified level.

The other 59 piers consisted of from 10 to 16 12-in. Hercules piles, 25 to 30 ft. long, on 1-ft. 6-in. to 2-ft. centers. Work was started on Mar. 9, 1914, and proceeded at the rate of about one pier per day. All pier locations were made from two lines, one on Fifth Ave., the other on 27th St. On Mar. 30, 23 piers were ready for grillages, and 19 were open, with work in progress.

The piers along the southern line of the building required that chases be cut in the party wall and in the independent wall (Fig. 2), to allow play for the hammer. In these instances, the concrete bed laid over the completed piles was carried up under the wall to strengthen it. Alternate piers were worked, to give the concrete a chance to set and take load. For instance, along the party wall Pier 11 was driven first; then No. 19, 8 and 15, respectively. Piers 3, 7 and 10, with the exception of two piles in the latter, just grazed a partition wall, as shown in the drawing. All the piles of these three piers were driven, with the exception of the two which interfered in Pier 10, which will be driven after the wall is removed.

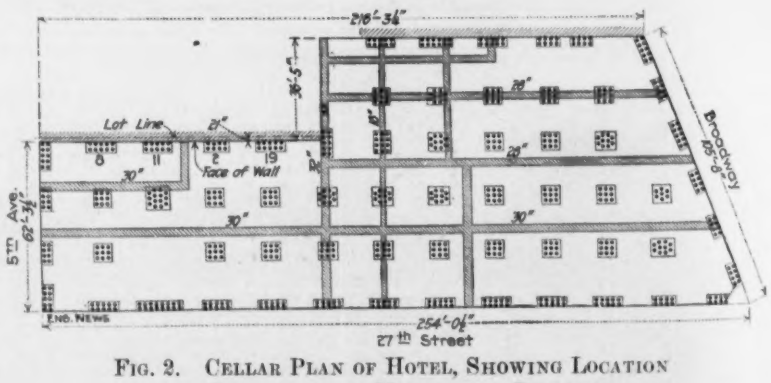


FIG. 2. CELLAR PLAN OF HOTEL, SHOWING LOCATION OF PIERS FOR THE MERCANTILE BUILDING

The interior walls of the cellar were bearing walls, built of stone faced with brick, and very heavy. The foundation rested originally on 8-in. piles 8 ft. long. The pile heads were encircled by an iron ring 12 in. wide.

These piles were badly rotted and had long before ceased to carry load. The hotel was built 41 years ago.

HANDLING MATERIAL AND BUILDING PIERS—The sand and gravel for the concrete were dumped from the street into the cellar vaults through sidewalk chutes. The piles and reinforcing rods were trucked to the site, carried into the first floor of the hotel and passed down through openings punched in the floor above the interior piers. These openings between the cellar and first floor were made wherever possible, to increase the headroom over piers. Where a pier location occurred wholly or partly beneath a wall, the piles were forced down by the Breuchaud

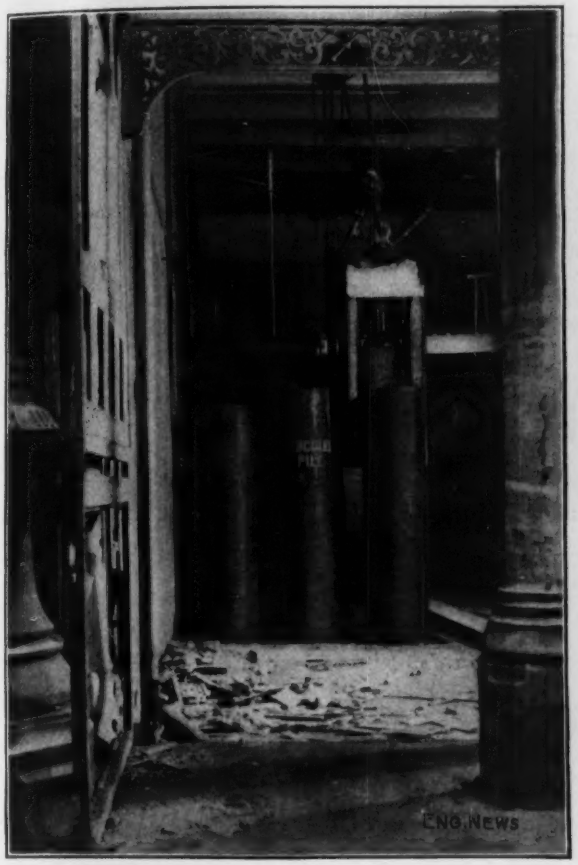


FIG. 3. STARTING A PIER ABOVE THE FIRST-FLOOR LEVEL

jacking method, whereby a breach is knocked in the wall, and a 100-ton jack is placed upon the pile, and under the wall, which is used for resistance to the thrust of the jack. Where this method was necessary, the pile lengths were only 4 to 5 ft.; with open driving, they were 20 ft. long.

The usual penetration was 25 to 30 ft. The tops were cut off from 13 ft. 2½ in. to 23 ft. 9 in. below curb.

After a pier is located, excavation proceeds to the point of pile cutoff, where a wooden separating-frame, such as shown in Fig. 4, is placed. Then, if possible, a hole is knocked through the floor above and the piles for the pier are lifted through and all set in place. A steam hammer drives the piles. It is suspended by a 3-ton chain block, from 12x12 timbers laid at right angles to the second-floor beams, which are wrought iron I-beams. Air power was used to escape the annoyances of a steam exhaust in the cellar.

After all the piles in a pier are driven to refusal, they are blown out with a series of air blasts using heavy pressure, which removes about 3 ft. of muck (flowing wet sand) per blast. They are then cut off even at the required level, by means of an oxyacetylene torch. As the cellar floor of the new building will be 4 ft. below the present level (10 ft. below in the boiler room) the piles are cut off some feet below the present floor level. A maximum of four 2-in. reinforcing rods spaced by wire separators* are placed in each pipe.

After the concrete is poured, the rods are cut off flush, and a cast-iron cap is fitted over the pile heads; through a hole in the cap, cement grout is poured and the pile thus sealed. Reinforced concrete is laid around the piles,

FIG. 4. PIER DRIVEN BELOW FIRST FLOOR, SHOWING SEPARATING FRAME AND PLUMBING WEDGES

one foot below the cap, and 1½ ft. above. On this foundation, the grillages formed of two 24- to 30-in. I-beams bolted together, are laid.

The method of driving the piles of a pier is well illustrated in Figs. 3 and 4. Fig. 3 is a view from Fifth Ave., looking through an old store into the reading room of the hotel, and shows a pier composed of 12-in. Hercules piles being started above the first-floor level. The first and second floors are 14 ft. apart, and the hammer clears the second floor by about 5 ft. Fig. 4 shows the same pier driven below the first-floor level, and near the separating frame. The piles are plumbed during the first part of their descent, by means of the wood wedges

*Care must be exercised in using these separators as it has been found that the concrete often does not pass them freely, which leaves a void beneath the separator.

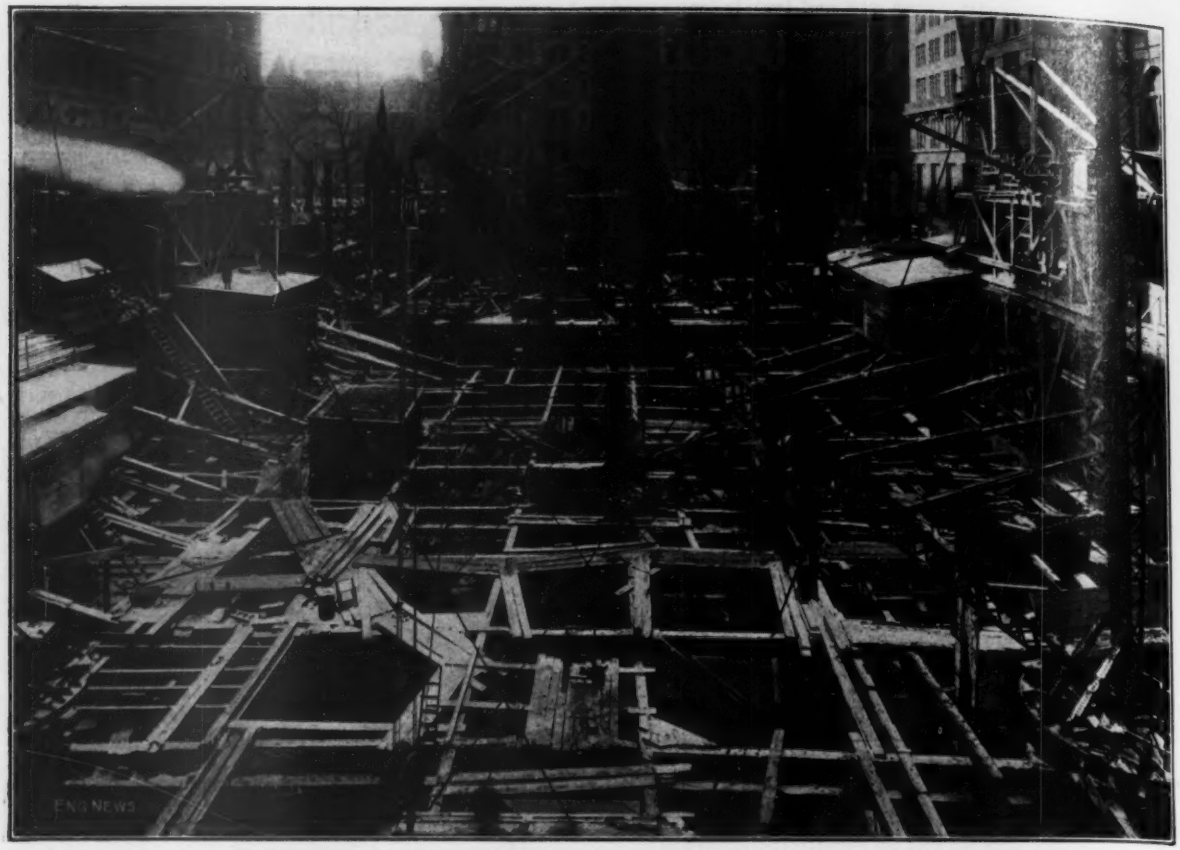


FIG. 1. EQUITABLE BUILDING; CROSS-LOT TIMBER BRACING FOR CONTINUOUS COFFER-DAM
(Looking toward Broadway)

shown in the halftone, placed between the cross pieces of the frame and the piles. Two men operate the hammer while two others plumb the piles. Beyond a certain penetration, plumbing is, of course, impossible, and they are driven straight to bedrock. Refusal is considered 100 blows to the ⅛ in. of penetration.

Power was furnished by the hotel plant, for lighting, for operating the compressor and the hoisting engine (operating a hoist for removing débris from the cellar), both situated on the street, and for a concrete mixer located in the cellar. The vacuum-cleaning tanks of the hotel were used as air-receiving tanks, and fed by the compressor. From these tanks air lines run to various parts of the work.

During the driving operations excess débris was removed by a hoist placed at the northwest end of the building. When the wreckers have gone, two stiff-leg derricks will be placed on piers, at the first-floor level. The derricks will have 60-ft. booms and 40-ft. masts, and by means of dump buckets will remove all the dirt without having to be shifted.

The Underpinning & Foundation Co., of 290 Broadway, New York City, who are doing the work, maintained a day force and a night force of 30 men each, from Mar. 9 to Mar. 30, when the fact that they were so far ahead of the wreckers permitted them to slow down. The work is now practically completed.

The Mercantile Building will be erected and owned by the Johnson-Kahn Co., New York City. The architects are Schwartz & Gross. Laurence A. Ball is consulting engineer.

Steel Erection for the Equitable, Heaviest Office Building in the World

The Equitable Building, now under construction in New York City, on the block bounded by Broadway on the west, Nassau St. on the east, Cedar St. on the north, and Pine St. on the south, from its great area presents an interesting problem in heavy erection. The steel erection was made especially difficult by extensive cross-lot timber bracing, which holds the basement retaining-wall until sufficient steelwork has been installed to take the load. It was necessary to set the derricks and with them erect the steelwork for the three stories below ground, all without damage to the cross-lot bracing.

To provide foundations for the exterior columns and to retain the surrounding properties, a continuous reinforced-concrete coffer-dam comprising individual caissons about 30 ft. in length, was built around the lot. The coffer-dam has a perimeter of about 1000 ft. and is 80 ft. high and 6 ft. thick.

The side-thrust of the coffer-dam is taken up by the system of timber bracing shown in Fig. 1, until sufficient steelwork has been erected to serve this purpose. The

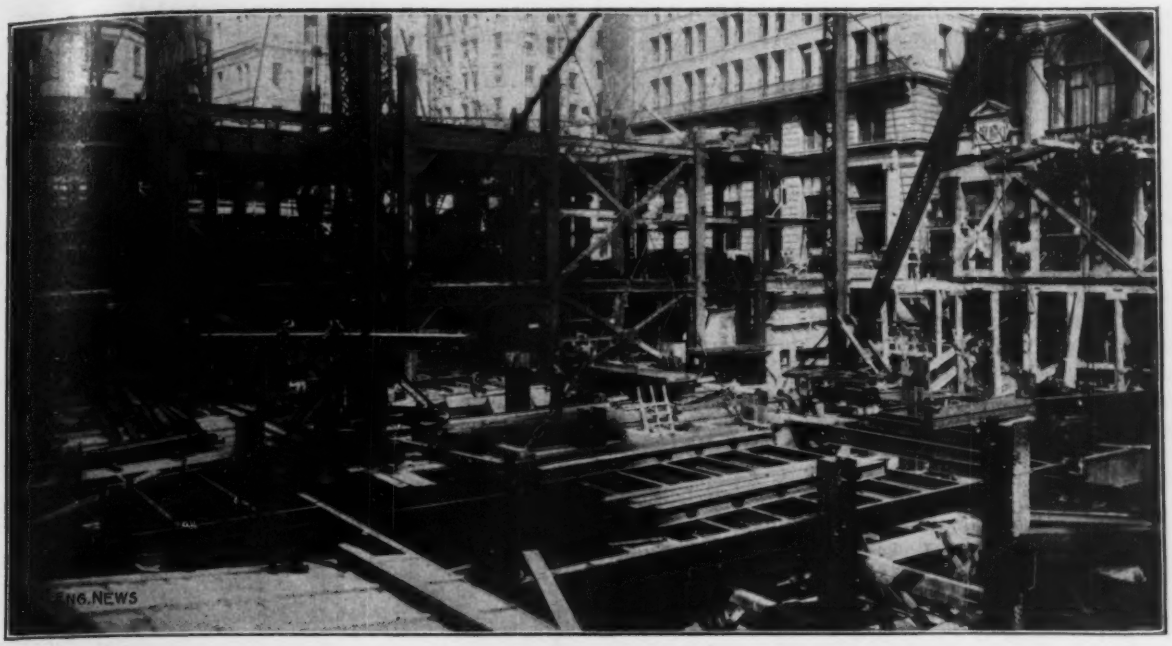


FIG. 2. SHOWING STEEL ERECTED TO THE SECOND-FLOOR LEVEL, BROADWAY END

(The middle bay will form the main corridor and extend through to Nassau St., being intersected at right angles in the middle by another through corridor. At the right of this bay is shown a bent of wind bracing.)

floors of the basement and two sub-basements (especially the latter) are designed to take the side-thrust of the coffer-dam walls.

The new building will be about 160x312 ft. in plan and about 500 ft. above the street and 65 ft. below at lowest point. It is considered a 36-story building, but there will be intermediate floors at the 3d- and 34th-floor levels, making 38 floor levels. A large two-story penthouse on the roof occupies the space bounded by the column lines 43-48, 91-96 (Fig. 4), making 40 floor levels above grade, and 43 tiers of steel above the footings.

Above the seventh floor, large courts extend in from Broadway and from Nassau St. On Cedar and Pine St. the building line is unbroken. The plan above the seventh floor is therefore H-shaped. The elevators, stairways, lavatories, smoke-stack, etc., will be placed in the center or core of the building. All offices will have an exterior exposure.

The old Equitable Building burned in January, 1912. The shell was taken down between July and November of that year; and in February, 1914, the foundations of the new building were completed. Steel erection commenced in the latter part of January, 1914.

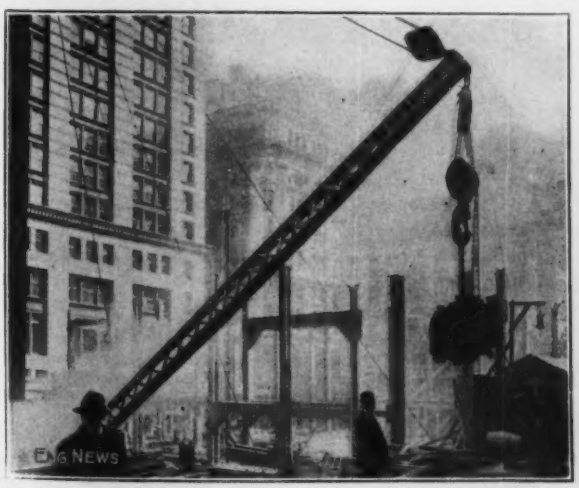


FIG. 3. HANDLING MATERIAL FROM PINE ST. TO THE BASEMENT FLOOR

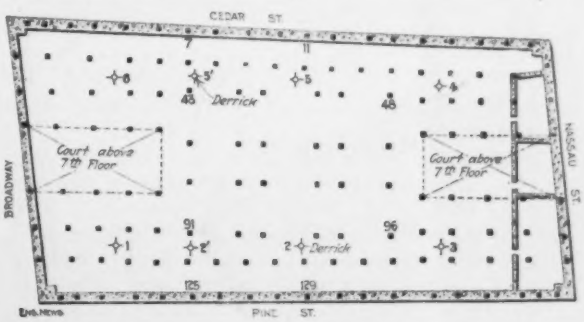


FIG. 4. COLUMN PLAN FOR ALL FLOORS

The steelwork was erected to the second floor by six steel guy derricks, with 76-ft. masts and 65-ft. booms. The heaviest column weighed 32 tons. Above the second floor the heaviest piece to be handled weighs about 16 tons, and 15-ton derricks with 90-ft. masts and 85-ft. booms replaced the original six. The longer reach of these lighter derricks rendered them much more useful in handling material from the street. The general position of the derricks on each tier is shown in Fig. 4. The first derrick was set up (No. 6) on Jan. 26. The other five were installed in the following order: 1, 4, 3, 5 and 2; all being in operation by Feb. 14. In each instance,

the derrick was set up immediately upon the completion of the piers in its vicinity.

Derricks 6, 1, 3 and 4 were each first erected on two bents, constructed of 12x12-in. sticks, extending 4 ft. above the top of the cross-lot bracing and entirely independent of it. By this method the derricks were prevented from stressing the timbering, which was designed for the side-thrust of the coffer-dam walls, and not for vertical loading or the vibration from derrick operations.

After the steelwork west of wall columns 7 and 125 was erected, derricks 1 and 6 set up derricks 2 and 5 on the basement steel at positions 2′ and 5′, respectively (Fig. 4). These derricks proceeded to erect the basement steelwork eastward to columns 11 and 129; moving forward along the basement steel, erecting steelwork ahead, similar to the moving of a traveler. In this way, liability to accident to the cross-lot bracing was reduced, and the expense of building bents for supporting the derricks was eliminated.

The total steel, aggregating 33,000 tons, is fabricated by the American Bridge Co., at Ambridge and Pencoyd, Penn., at Trenton, N. J., and at Brooklyn and Elmira, N. Y. It is shipped to Greenville, N. J., lightered over to New York City in the vicinity of the Battery, and trucked to the job. Each derrick handles the steel from the street for its particular section. Fig. 3 shows a derrick unloading steel from a truck on Pine St.

Prior to the completion of the basement floor, large steel bents rising 3 ft. above the cross-lot bracing, were built to receive the steel until erection. As soon as the steel to the basement-floor level was set, the columns to the second story were erected, without moving the derricks. The floorbeams were then set and the derricks lifted to the second story.

The Broadway end of the building was erected to the second story, as shown in Fig. 2, and was then held back while a complete tie was made through the building from Broadway to Nassau St., to check connections. When the steelwork to the first floor was set, the erection progressed as a whole. On Apr. 1, the steelwork for the third floor was being erected, the work progressing at the rate of two stories per week.

The steelwork is being erected by the Thompson-Starrett Co., 49 Wall St., New York City (George Simpson, Chief Engineer). The erection superintendent is Howard S. Gardner. E. R. Graham and J. G. Glaver, of D. H. Burnham & Co., Chicago, are architect and structural engineer, respectively.

Design of I-Beam Purlins

By William Vetter*

Let w be the combined dead-load (including roof covering and purlins) and snow load; let w' be the wind load; both being on one panel. Also let θ be the angle of inclination of the rafter with the horizontal. Resolve w into two components, one normal and the other parallel to the rafter, and form the following equations:

Normal,

$$N = w' + w \cos \theta.$$

Parallel,

$$P = w \sin \theta.$$

If I/c and I'/c' are the section moduli about the gravity axes of the purlin section, normal to N and P respectively; S the maximum fiber-stress; and L the length of the purlin in inches; then:

$$S = \frac{L}{8}\left(\frac{N}{I/c} + \frac{P}{I'/c'}\right)$$

Now let $I/c \div I'/c'$ be represented by K. Substituting K and solving I/c, we have:

$$I/c = \frac{L}{8S}(N + KP)$$

Manner of Using Equation—Select a value for K and solve for I/c. The value of I/c thus found should lie in the group to which K belongs. If it does, select the shape that has a value of I/c slightly greater than calculated. If it is a larger or smaller value than corresponds to K, take a larger or smaller value of K and recalculate. Usually only about three trials are necessary if the initial value of K is for a 10-in. shape.

The values of K in the following table are for Cambria shapes:

AVERAGE VALUES OF K

I-BEAMS		CHANNELS	
Depth	K	Depth	K
3 in.	4.14	3 in.	5.14
4	5.16	4	6.56
5	5.87	5	7.85
6	6.58	6	8.78
7	7.17	7	9.79
8	7.62	8	10.53
9	8.05	9	11.17
10	8.43	10	12.01
12	9.64	12	12.83
15	11.33	15	13.64
18	12.77		
20	13.28		
24	14.53		

The average values for I-beams have an average difference from the true values of about 0.08.
The average values for channels have an average difference from the true values of about 0.20.

Example—In a certain roof truss the values w = 3200 lb., w' = 3000 lb., and θ = 26° 30′, have been calculated from given data.

$$N = 3000 + 3200 \cos 26° 30' = 5860 \text{ lb.}$$

$$P = 3200 \sin 26° 30' = 1430 \text{ lb.}$$

The length L is 180 in., and S is 16,000 lb. per sq.in. Then, trying K = 8.43 (10-in. I-beam),

$$I/c = \frac{180}{8 \times 16{,}000}(5860 + 8.43 \times 1430) = 30.8$$

A 10-in. 40-lb. I-beam has a section modulus of 31.5. Hence this I-beam will be used as an intermediate purlin.

The design of the end purlins is accomplished in the same manner, but by taking half of N and P. Hence

$$I/c = \frac{180}{8 \times 16{,}000}(2930 + 12.01 \times 715) = 16.2$$

Here a 10-in. channel has been assumed. Referring to the handbook it is seen that a 10-in. 25-lb. channel has a section modulus of 18.2. Hence this channel will be used as an end purlin.*

NOTES

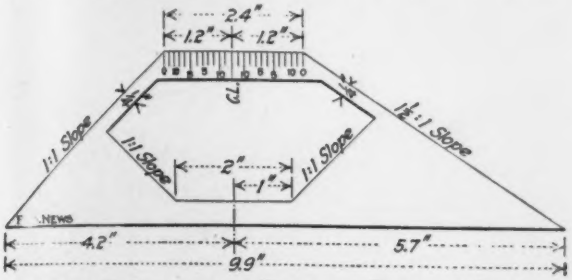
Can Asphalt Be Torn Up by Steam Shovel? Information is wanted by a general contractor in regard to tearing up old sheet-asphalt without disturbing or injuring the concrete base. The questions are: What are the best methods of removing it? Can it be done with a plow; what kind of a plow? Can the asphalt be removed by a small steam shovel.

*2463 Marion Ave., Fordham, New York City.

*The method of calculation is not correct for channels and other unsymmetrical sections, on account of torsional stresses set up when the load is not in the plane of one of the principal axes of the section. This effect is commonly disregarded, in practical designing.—EDITOR.

with swivel dipper and forward crowding motion? Would the wear and tear on such a machine be prohibitive? What cost data are there on asphalt-pavement removal? "Engineering News" would be glad to publish answers to these queries.

Beam Deflection under Triangular Loading—A reader who is not very handy with mathematics inquires concerning the deflection of a simply-supported beam under triangular distribution of load, the load varying from zero at one end to a maximum at the other. He says that "The American Civil Engineers' Pocketbook" gives a formula for the amount of the maximum deflection, but does not locate the point at which the maximum deflection occurs. The fact is that the maximum deflection occurs so near midspan that the difference is negligible. Perhaps some reader can give the exact formulas covering triangular as well as trapezoidal loading.

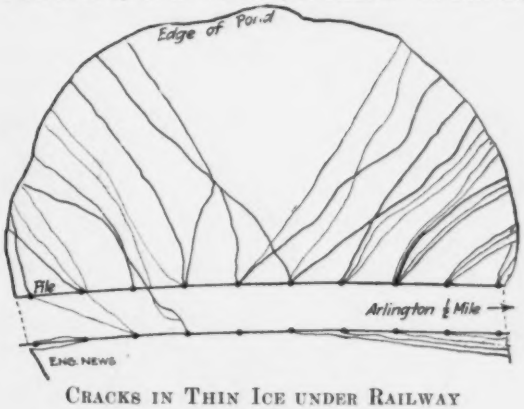


SLOPE TEMPLATE FOR PLATTING RAILWAY CROSS-SECTIONS

Template for Platting Railway Cross-Sections—The slope template shown by drawing herewith is recommended by A. G. Kindred (N. & W. Ry., Roanoke, Va.), as a great timesaver. Its special use is on second-track construction, or on new double-track work. It is made of xylonite ⅛ in. thick. The scale at the top is figured both from center and from outer corners; graduations of 0.1 in. make the top represent a 24-ft. roadbed, but the graduation makes it almost as easy to use other widths.

An Unusual Truck-Load—The member carried on the triple trucks in the view herewith is the top chord of a balcony truss for the new McBride Theater, Victoria, B. C. The dimensions of the chord are approximately 26x32 in., 72 ft. long. The truss supporting the entire balcony is very heavy, as reflected in the fact that the top chord weighs 24 tons. The peculiar shape of the chord is due to the fact that the end panels are sloped up to give room for a passageway below; the curve of the balcony floor gives sufficient clearance for this slope. Pinney & McLellan are contractors for the building. The steelwork was fabricated by the American Bridge Co. H. W. Bittman, of Seattle, Wash., is structural engineer for the theater.

Ice Cracks Caused By Trestle Vibration—The sketch herewith shows cracks in thin ice on a pond crossed by the Chicago & North Western Ry. about ½ mi. east of Arlington, Neb., sketched by F. M. W. Price, of Lincoln. He attributes



CRACKS IN THIN ICE UNDER RAILWAY TRESTLE

the peculiar arrangement of the cracks to vibration in the piles of the trestle, from trains crossing. The circumstances are recounted as follows:

"This ice commenced to form about 5 p.m., Mar. 26, and when I crossed the next morning my attention was arrested by the direction of the cracks in the ice proceeding from the outside pile in each bent. They did not radiate in both directions from each pile as might have been expected, so I made a reasonably accurate drawing of it.

"The bridge is on curve with about 2¼-in. superelevation. The bents are four piles, well capped and braced. The spans are 20 ft.

"It will be noted that the cracks proceeding from four of the bents from each end of the bridge, radiate toward their respective ends of the bridge, while those from the two middle bents radiate in both directions. Of course after the vi-

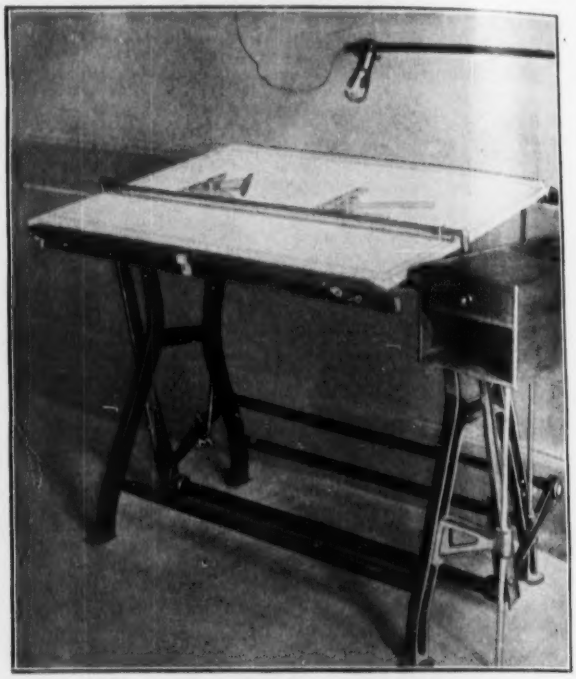
AN UNUSUAL TRUCK LOAD

brations of the first train in each direction had caused the ice to crack, the vibrations from succeeding trains would simply tend to widen the cracks and not to form new ones, unless the vibrations were greatly increased (as by greatly increased speed of some trains above those which preceded them). If this drawing be taken as an actual chart of the vibrations of a bridge caused by a moving train and the direction of the force exerted on the outside rail of a curve then it would indicate that the engine does not cause much if any vibration until it is well on the bridge."

Mr. Price believes that the directions of the cracks are parallel to the oscillation of the bents, and therefore that the push of the train against this bridge makes an angle of 40° to 65° with the track; further, that the difference of speeds of eastbound and westbound trains (because of the station ½ mi. east) accounts for the different regularity of the cracks at the two ends of the bridge. The case gives much opportunity for speculation.

Porous Concrete Blocks to be laid up in vertical rows so as to form drainage wells are being made for the Kensico Dam now under construction near White Plains, N. Y., for the new Catskill Water Supply of New York City. These blocks are 3 ft. square in plan, with an interior 16-in. hole and are cast of 1:2:4 concrete. They are spaced 15 ft. apart and are expected to intercept and collect any slight seepage which may penetrate the dam through the upstream face. The remainder of the dam is of solid concrete laid behind cast concrete facing blocks.

New Drafting Table with Swing Blade Attachment—The drawingboard holder consists of two castings mounted on a rocker shaft, with wooden front and back pieces between which the drawing board is clamped by thumb screws, which also serve to adjust its parallelism with the swing straightedge blade. The swing blade attachment enables the draftsman to manage a long straightedge with one hand. The ruling edge is carried at each end by a stiff swing, nearly balanced by long adjustable springs at the back, the slight excess of weight of the swing being received in a finger bar,



NEW DRAFTING TABLE WITH SWING-BLADE ATTACHMENT MADE BY D. J. KELSEY, NEW HAVEN, CONN.

over the ruler, and transmitted to the ends of the ruler, so as to compensate for any slight unevenness in the drawing board. The swing is hung from a rocker shaft and so adjusted that a slight lift raises the ruler quite a space above the drawing board, where it will remain supported until wanted and pulled down again. This feature is claimed to be particularly convenient when papers are lying on the drawing or when applying tracing cloth or changing drawing boards, the frame being so made as to take different sizes of boards. The illustrations show also a draftsman's universal square and protractor, consisting of a right-angle with hinged scale, which may be set at any angle 0° to 90°.

Both the table and triangle are made by D. J. Kelsey, 77 Livingston St., New Haven, Conn. The table complete costs $84, and the triangle, or universal square, $4.75, with attached scale.

CONVERSION TABLE FOR HOURS AND DEGREES

H			and			M			give			Deg. (°)					H
M			and			S			give			Min. (′)					M
S	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	S
0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	0
1	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	1
2	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	2
3	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	3
4	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	4
5	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	5
6	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	6
7	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	7
8	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	8
9	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	9
10	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	10
11	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	11
12	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	12
13	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	13
14	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	14
15	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	15
16	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	16
17	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	17
18	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	18
19	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	19
20	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	20
21	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	21
22	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	22
23	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	23
24	360	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93	F
MS	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	MS

Conversion Table—The accompanying table for converting time into degrees, minutes and seconds of arc, or vice versa, is sent to us by C. H. Bainbridge, Instructor in surveying, Rensselaer Polytechnic Institute, Troy, N. Y.

Example: Change 112° 54′ 37.5″ to time. Opposite 112, on the left in the column headed H M S find 7, and above, top row, 28; 7 hr. 28 min.; opposite and over 54, 3 min. 36 sec.; opposite and under 37, 2.47 sec.; opposite and under 5, 0.33 sec.; changing decimal point, 0.033 sec.; added together gives 7 hr. 31 min. 38.50 sec.

Change 7 hr. 31 min. 38.5 sec. to arc measurement. Reduce mentally to multiples of 4, viz: Opposite 7 under 28 find 112°; opposite 3 under 36 find 54′; opposite 2 find 30″; opposite 5 find 7.5″; changing decimal point, 7.5″; added together gives 112° 54′ 37.5″. For fractions the row opposite F must be used.

This table and the directions for its use of such size as to be parted in the back of an ordinary field note-book has been found convenient by students in astronomical surveying at the Institute.

Editorials

The Day's-Work Plan of Carrying on Public Works

From various parts of the country reports indicate increasing agitation to secure the adoption of the day's-work plan instead of the contract plan in carrying on public works. The New York legislature, at its recent session, passed a law increasing the power of the New York City Public Service Commission to construct part of the New York subway system by the employment of labor directly instead of by letting the work to contract. This legislation was urged by the Public Service Commission and its engineers as we understand, not with the idea of changing the general policy of the Commission hitherto of doing most of its work by contract, but to enable the Commission to carry out certain classes of work which could perhaps be better performed in this way than they could if placed under contract. The passage of the bill was strongly opposed at a hearing before Mayor Mitchel by representatives of the General Contractors' Association and was disapproved by him.

In New Jersey one of the State Commissions recently desired to carry out certain road construction by the direct employment of labor, but was stopped by a statute which compels the letting of contracts for all such work. The law in question appeared to have been passed, however, with the idea of protecting the public against possible corruption or wastefulness in carrying out work with political appointees rather than with the desire of protecting contractors.

As one goes westward the tide of public opinion against the contract system becomes more evident. In Chicago the city is now constructing two bridges by its own forces and Mayor Harrison has recently publicly announced himself in favor of the plan of doing all city bridge work by day labor rather than by letting contracts. That the labor element in politics as well as the Socialist party have long been bitterly opposed to the contract plan of conducting public works is pretty well known. Several prominent leaders in the Progressive party have also announced their approval of this doctrine; and the older parties, as a matter of political expediency, are not likely to make strong opposition to the change even if they do not aid in bringing it about.

Engineers will agree that the question whether any such change in policy is desirable will turn upon the question under what sort of management the day's-work plan is to be carried out. If the work is to be done under a political organization with all that that implies, the taxpayers who pay for the job will be out of the frying pan and into the fire. On the other hand, wherever a businesslike, permanent organization can be established to conduct work it will be an advantage to give any such organization a free hand either to let contracts or to carry on work itself, according to circumstances, which may make either plan preferable. In this way the most desirable plan of doing the work should result.

The Burden of Costly Passenger Terminals

We have several times discussed in these columns the burden which is being laid upon American railway companies by the enormous expenditure on costly passenger terminals, which has been made during the past dozen years. The pace was set by the great terminal stations built by the Pennsylvania and New York Central railways in New York City, with the new stations of the Pennsylvania and Baltimore & Ohio at Washington, D. C., and of the Chicago & Northwestern at Chicago.

High officials of the Pennsylvania have testified that their investment in the Manhattan terminal is now regarded as entirely nonproductive. Any benefit which may accrue to the company in the shape of increased traffic that would not otherwise have been obtained is doubtless fully offset by the heavy taxes on the large area of valuable real estate in the heart of New York City, which the terminal occupies. The Pennsylvania, however, was in the fortunate position of being able to pay for this great terminal, in large part, out of the surplus earnings of the prosperous years, during which it was under construction. The New York Central Co., on the other hand, has been obliged to raise the money for the new Grand Central station almost entirely by bond issues and short-term notes. The fixed charges on this huge investment represent a standing burden upon the company's earnings, which means a material reduction in the company's dividends and a handicap to its expansion in other directions for which investment is demanded.

A definite statement, showing the extent to which expensive passenger terminals increase the cost of transportation is furnished in a recent report to the stockholders of the New York, New Haven & Hartford R.R. by President Howard Elliott. We quote as follows from the report:

> The increase in rentals ($2,162,100 since June 30, 1913) is due largely to the constantly increasing investment in the Grand Central passenger terminal at New York. In 1903 the payment made by the New Haven company for the entrance to New York City and for the use of the passenger terminal was $1,038,182. For the year ending June 30, 1913, it was $2,983,969, or about 30c. for each passenger. The cost will be more for the year ending June 30, 1914.
>
> The average revenue from each passenger carried one mile on the New Haven road is only 1.77c., and the average payment per passenger is only 32c. This low average is due to the large number of passengers carried in suburban territory at rates which range from ½c. to 1c. per mile.
>
> At the same time the expenses of this commutation traffic are particularly heavy on account of the very burdensome cost of the passenger terminals both at New York and Boston. Notwithstanding the extremely low commutation rates the efforts of some of the public authorities have been to reduce them still further. The Public Service Commission of New York ordered substantial reductions in the very low commutation rates between New York suburban points and New York City. The Supreme Court of New York set aside this order, but the New York Legislature, which has just adjourned, passed an act making the same reductions.

It ought to be clear to even a wayfaring man that a

railway or any other concern cannot long continue to do business at a cost greater than the return it receives. If it had been proposed to the New Haven commuters that they should pay the actual cost of the magnificent building at 42d St., they might have been less enthusiastic over it. But it is clear enough that in the long run the commuters must do this, unless other traffic carried by the railway is to be charged more than its fair proportion in order to make up the deficiency.

If the example of New York City were to be followed the country over and passenger stations involving a fixed charge of 30c. per passenger using them were to be built every where, the bankruptcy of all the railway corporations would promptly follow. This would happen even if the rates of fare were made high enough to cover this fixed charge, for such an increase of fares would cut down travel so much that passenger traffic would be everywhere conducted at a loss.

As we have before pointed out, such enormously expensive passenger stations are unknown in Europe and are a recent American development. The serious thing is that expenditures of this sort are being forced on the railways by legislatures and State Commissions, who forget that in the long run the public itself must pay for such luxuries.

Parapets to Safeguard Railway Bridges

"Two or three cubic yards of masonry saved a fatal disaster." That is the headline which might very appropriately be placed over the account which appears elsewhere in this issue of the derailment on Apr. 12, on the New York, New Haven & Hartford R.R. The circumstances briefly summarized are as follows: A fast express train was running on the outside track of the four-track road. The electric locomotive at the head of the train was derailed at a curve and after running a considerable distance along the ties diverged to the side of the roadbed just as it approached a highway undercrossing consisting of two masonry arches side by side. Some unknown draftsman or engineer who designed this crossing provided substantial parapets at the sides of the track. They were low parapets, rising not more than one foot or so above the rail level and were probably built more to give a good looking finish to the arch below it than with the idea of safeguarding trains. The parapets were, however, very substantial pieces of masonry work, being made up of large blocks 2 ft. or so in width. When the derailed locomotive reached this crossing, it had swerved far enough from the rails so that it struck this coping with great force. The huge stones, some tons in weight, were swept off from their supports and thrown into the road below.

A member of the editorial staff of ENGINEERING NEWS who visited the scene of the wreck shortly after it occurred, believes that it was collision with this parapet which diverted the derailed locomotive back toward the rails and enabled it to cross the bridge without plunging over the side into the road below, as would otherwise probably have occurred. It is, of course, impossible for anyone to certainly say whether this would or would not have happened had there been no parapet over the bridge, but the probabilities seem strong that in this case the presence of these two or three cubic yards of masonry made all the difference between the accident which caused no loss of life and only trifling injuries to persons and one which might very easily have proved one of the most serious in the history of the company in the number of killed and injured. We believe the New Haven officials may well congratulate themselves on having narrowly escaped a serious disaster and a disaster moreover, which, if it had occurred might easily have proved the last straw in forcing the unfortunate New Haven company into bankruptcy. In the present state of public opinion in New England, the New Haven railway cannot have a serious wreck without bringing down upon itself a storm of public indignation which it would be most difficult to meet. It is earnestly to be hoped that the freedom from serious accident on the New Haven which has continued since the new management was first installed may long endure.

It has seemed to us worth while to emphasize particularly this feature of the recent New Haven derailment since it serves to call attention to one of the weak points in American railway practice which ought to be remedied. We refer to the failure to place some sort of parapet protection at the sides of important bridges and viaducts.

It is probably true that on a large proportion of American railways the cost of such protection would not be justified; or, to put it another way, there are other directions in which the expenditure of that amount of money would secure greater results in the way of public benefit. There are, however, many miles of main-line trunk railways of very heavy traffic in the United States on which a much higher standard of safety ought to prevail, and where, in fact, such provisions for safety in the case of derailments can be defended on purely economic grounds.

There are, for example, a good many railway bridges built nowadays, the cost of which is half a million to a million dollars or more. It is well established standard practice to provide inside guard rails and outside guard timbers on the floors of all bridges and these are excellent so far as they go. The additional safeguard of a parapet guard to hold any derailed car body in line and keep it from striking one of the bridge web members would cost a trifling amount in comparison with the value of the structure which it protects, and besides the value of the bridge one must consider the human lives which are at risk and the great property loss which may be involved in a train wreck.

Such "collision struts" have occasionally been provided on important bridges; but they are still far from common on through bridges while nothing whatever is done as a rule on deck bridges in the way of parapet protection. On masonry structures, low parapets are usually constructed, but are designed rather to give the structure finished appearance than proportioned to act as an effective safeguard to withstand the lateral force of a derailed car or locomotive. In building a masonry structure, the additional cost of making a parapet sufficiently strong and massive to be a real safeguard to a derailed train would represent only a small percentage of the total cost. In England, where the safeguarding of human lives in railway service is much more emphasized than in this country, the provision of some sort of parapet protection for trains on high viaducts is, we believe, well nigh universal. This is done notwithstanding the fact that derailments of English rolling stock are much less fre-

quent loss of American rolling stock. In either country, however, every railway engineer must recognize that a derailment is always possible of occurrence at any point along a railway track; and reasonable provision to minimize the disastrous results of such a derailment is properly part of an engineer's responsibility.

Alfred Noble

The American engineering profession looked up to Alfred Noble.

The news of his sudden death will bring a sense of personal loss to thousands of engineers who had never met Mr. Noble personally, but who appreciated the great public service which he had rendered and realized that his great ability and strong personality had done much to raise the engineering profession in public esteem.

Elsewhere in this issue, in presenting to our readers a recent portrait of Mr. Noble, we have given a brief record of his life and professional achievements. It is fitting, however, that something more should be said in this place concerning the unique public service which Mr. Noble rendered. We believe it is within bounds to say that there are few men to whom the people of the United States owe a greater debt of gratitude for important services rendered at a time of crisis than to Alfred Noble.

In 1895, Congress was on the point of passing a bill providing for a government guarantee of the bonds of the Nicaragua Canal Co. There was a very strong sentiment in favor of the passage of the bill among members of both the House and Senate. The assurances held out were that the entire cost of building a ship canal across Nicaragua connecting the two oceans would be only $65,000,000. There were, however, in Congress, a few statesmen who were not swept off their feet by the great pressure exerted in favor of the passage of the bill. They put forth the plea that before the United States should lend its credit to the enterprise it should investigate the project through a board of engineers of its own selection.

This proposition was so entirely reasonable that it sufficed to defeat the bond-guarantee bill. In its stead an act was passed creating the Nicaragua Canal Commission, to be composed of one engineer from the Army, one from the Navy, and one from civil life. This Commission with a very small appropriation and a very limited time in which to work, was required to report as to the feasibility of the Nicaragua canal enterprise. President Cleveland appointed as the members of that Commission, Colonel (afterwards General) William Ludlow from the Army, Mordecai T. Endicott from the Navy, and Alfred Noble from civil life.

The situation was one which demanded engineers of ability with sufficient independence to form their own opinions and not be swerved from a straight course by the strong influences brought to bear by the corporation whose plans were under investigation. The report made by this commission showed that the advantages of Nicaragua as a canal route had been greatly overestimated and that the cost of building a canal there would be far greater than the estimates made by the canal company.

Those interested in the Nicaragua Canal enterprise adopted every possible means to discredit the report; but they were never afterward able to command a large measure of public support. The sound advice of these engineers saved the nation from lending its credit to a private corporation which, if it had undertaken the Nicaragua work, would have inevitably met failure.

The second great opportunity of Mr. Noble to render public service came when in 1899 Congress created the Isthmian Canal Commission, with instructions to find the best possible route for a ship canal across the Central American Isthmus. Mr. Noble was appointed one of the members of this commission and he and the late George S. Morison were recognized as its leading engineers. Without doubt, Mr. Noble's large experience, tactful firmness, and ability had large influence in determining the conclusions of the Commission.

It was this commission which after two years of surveys and investigation recommended that the United States should adopt the Panama route. The experience which has been gained since that time has fully confirmed the wisdom of the recommendations made by that commission.

It was seven years later when Mr. Noble had the opportunity to render what was, without doubt, the greatest public service of his life. The government had started construction work on the Panama route, and the question came up for decision as to whether a sea-level canal or a lock canal should be undertaken. To advise upon this momentous question, President Roosevelt created an International Commission of engineers, made up of five eminent members of the engineering profession representing foreign countries and eight prominent American engineers.

As most of our readers will remember, all the foreign engineers and three of the American engineers united in a majority report advising the construction of a sea-level canal. Five American engineers with Mr. Noble at the head stood out in favor of a lock canal. We say "Mr. Noble at the head," because from his long experience in connection with the lock at Sault Ste. Marie, he was better able than any engineer upon the commission to speak authoritatively with respect to the construction and operation of great ship canal locks. To Alfred Noble's discerning wisdom and independent judgment and to his willingness to stand in a minority in defense of what he believed to be right, the country owes it today that it did not undertake what we now know would have been the folly of a sea-level canal at Panama.

In the struggle which followed the submission of these two conflicting reports, Mr. Noble's ability and strong forceful personality had much to do with the final decision by which those in authority rejected the majority report and adopted that of the minority.

In reviewing these three great public services rendered by Alfred Noble to the nation it will be universally agreed that his name deserves high prominence in connection with our greatest national engineering work, the Panama Canal. It detracts nothing from the honor due to those who have borne the burden and heat of the days and years during the long period of construction at Panama to give honor to the great engineer whose sound judgment and incorruptible integrity enabled the nation to steer a straight course in undertaking this hugest of engineering feats and avoid the disgrace attendant upon disastrous failure.

It can be said of Mr. Noble, without fear of contradiction, that he won his way to the foremost position which he occupied as the leading American civil engineer of his time by sheer force of ability. Mr. Noble

was always a quiet and modest man, absorbed in his professional work. He never tried to advertise himself nor attempted to put his professional work in any way on a commercial basis. The great responsibilities which were laid upon him came to him because he was a man who inspired confidence in both his ability and his integrity.

For a dozen years in his early professional career he worked steadily, patiently and practically unknown as an assistant engineer on government work; but it was the experience which he gained there, even more than that which he gained in fields of other engineering work, which in later years, enabled him to solve correctly the vast problems which were laid before him in connection with the Panama Canal enterprise.

We may not take space to speak at length here of his other great works as an engineer, such as the Pennsylvania terminal in New York City. It is worth while, however, to emphasize the high regard in which he held his profession. Much of his time in recent years had been devoted to work for the benefit of the profession in connection with the engineering societies of which he was a member. Last year, he was President of the American Institute of Consulting Engineers and he had been for two years one of the Managers of the American Society of Mechanical Engineers. In 1903 he was President of the American Society of Civil Engineers.

One of the last pieces of work which he undertook and to which he had devoted a great amount of time and energy was in connection with a joint committee of the national engineering societies organized to frame a model code for the registration of engineers. Mr. Noble was the chairman of this committee and he devoted to the task a great amount of painstaking thought. It was characteristic of the man that with all the great responsibilities laid upon him, he was willing to give liberally of his time and energy to benefit the members of his profession.

Letters to the Editor

"Detaining Dams" for Flood Control

Sir—I notice in your issue of April 9 your editorial "Concerning Calamity Reservoirs," in which you state that Mr. Alvord's design for a dam providing permanent openings through the base for flood control is, so far as you know, a new type. You may be interested in a description of a dam of this type suggested by the writer as one possible method for the control of the Passaic River, in New Jersey, in 1903. You will find this description in detail on p. 34, etc., of the Annual Report of the State Geologist of New Jersey, for 1903. Diagrams are given showing the calculated effect of this method of control upon three typical floods. Quoting from p. 37: "In practical operation such a controlling dam would be provided with openings which would have no provision for closing, but which could not possibly, at any stage of the river, pass a greater quantity than 17,000 cubic feet per second."

C. C. Vermeule.

203 Broadway, New York, Apr. 10, 1914.

A Monument to Alfred Noble

Sir—American engineers will be universally shocked as the news is conveyed to them of the death of Alfred Noble, a man who has been honored with the presidency of the American Society of Civil Engineers, and who in his lifetime achieved a far greater honor in the universal respect in which he was held by everyone who knew him or knew of him.

It was not my good fortune to know Mr. Noble personally, except in a very casual way, but his life work has been an inspiration and an exalted example to me for twenty-five years, as I have no doubt it has been to hundreds of other engineers.

Growing out of this feeling, it has occurred to me that it is a very opportune time for the engineering profession in some unusual way to recognize the value of his services to the world at large, as well as to engineering. Can we not now inaugurate a strong movement having for its purpose the erection of some suitable monument or memorial illustrating in some degree to generations to come the great work Mr. Noble performed and the loss the nation suffers in his death?

Hugh L. Cooper.

101 Park Ave., New York, Apr. 20, 1914.

[In view of Mr. Noble's great services to the nation in shaping the plans for the Isthmian Canal enterprise, it would be most appropriate if a memorial to him were planned in connection with that work.—Ed.]

The Evil Results of Pseudo-Engineering

Sir—Here is an incident which just came to the writer's knowledge, and which should interest your readers.

A few years ago, the town of Valentine, Neb., with a population of about 1000, issued bonds to build a municipal hydro-electric plant. A self-proclaimed engineer was employed, for a fee of $500, to prepare the plans and specifications. The earth-fill type of dam was chosen. No core wall of any kind was used. The material for the fill was largely sand, although a very fine sand. The fill was made in the winter and was compacted only by flushing. The spillway was placed about the center of the dam and was made by putting a 6- to 8-in. layer of concrete on top of the earth fill, extending it clear to the toe on the downstream side and about two-thirds of the way down on the upstream side. A concrete drain, large enough to take the average flow of the stream, was placed under the spillway. This drain was closed by a wooden gate operated from the top of the spillway.

The first time the dam was filled, the water rose to within a few inches of the top of the spillway when the dirt settled under the concrete and the whole spillway went out. The turbines have not turned once.

The town now has a $43,000 debt, is buying its light from a private plant, and has about reached the legal limit of bonded indebtedness for cities of this class so that it can expend only a limited amount to repair the plant. Indeed, it is doubtful if the stream is large enough to furnish power anyhow. The writer would guess that it is flowing at the rate of about 150 sec.-ft. now; in dry weather it would not reach that. The turbines were to operate under a head of 20-25 ft.

No comments are needed on this depressing calamity. The question is what are engineers as a body, going to do to prevent repetitions of the story?

M. A. REPASS.

Valentine, Neb., Apr. 4, 1914.

Improving Reinforced-Concrete Design

Sir—The papers by Charles A. Gilchrist, one of which appears in your issue of Mar. 26, 1914, on Internal Stresses in Reinforced-Concrete Beams, bring out some truths concerning this subject that will probably fail to make the impression that they might on account of the fact that they are entirely surrounded by mathematics. Practical engineers do not like to wade through seas of mathematics to reach islands of truth.

One of these truths is that steel in concrete is practically useless for carrying shear (as shear in the steel). It was common practice among designers a few years ago to design stirrups for shear, shear in the steel. In fact one book boldly gives this method of design when the stirrups are vertical. Others use vague language about "stress" that could be interpreted in the same way. Only a few years ago all building codes allowed 10,000 to 12,000 lb. per sq.in. shear on rods in concrete. There is no doubt that many designers still adhere to it. I showed up this practice as totally wrong about eight years ago.

Another truth that Mr. Gilchrist discovers is that stirrups do not take part in bearing the primary stresses of a beam. He finds that they help some, something on the principle that "every little helps." I have been trying for eight years to convince engineers that stirrups are about as asinine a piece of tomfoolery as could be invented.

Mr. Gilchrist further finds that stirrups and the main reinforcing rods should be joined with a curve and not a sharp angle. For this same period of years I have been trying to emphasize this also. It leads logically to the conclusion that the main reinforcing rods should be curved up into the upper part of the beam toward the support.

Mr. Gilchrist finds that these bent-up rods should be anchored in the upper part of the beam. This, too, could be found in a series of articles in ENGINEERING NEWS, in 1906. If Mr. Gilchrist, by training the ellipse or the "shamrock" of stress on the problem, can discover that the rodded column is in the same class with all of these other monstrosities, he will be doing the world a service. But it is doubtful if he can get engineers to take up with these needed reforms unless he can reach them through the medium of unlimited free literature.

EDWARD GODFREY.

Monongahela Bank Bldg., Pittsburgh, Penn.,
Apr. 11, 1914.

The First City Managership in Pennsylvania Filled by a City Engineer

Sir—In ENGINEERING NEWS, of Apr. 2, 1914, I note the announcement that Inglewood, Calif., has appointed its City Engineer as City Manager. I cannot resist calling attention to the fact that Inglewood has nothing on Titusville, Penn., for on Dec. 15, 1913, the Council of this city appointed its City Engineer, H. A. Holstein, City Manager, adding a nice increase to his salary as City Engineer.

Mr. Holstein has been City Engineer of Titusville for nearly nine years, and has had charge of about $250,000 worth of city improvements in that time, and had demonstrated his worth sufficiently to warrant the Council in appointing him City Manager—the first one in the State of Pennsylvania.

I attach hereto a copy of our ordinance covering the creation of the office, and defining the duties, also the ordinance which distributes the executive powers of the city government, and defines the duties of the different Superintendents who form the Council.

L. O. BRADLEY,
Supt. Public Safety.

Titusville, Penn., Apr. 9, 1914.

[The ordinance creating the office of City Manager for Titusville, with the omission of formalities, is as follows:

Sec. 1. Be it ordained by the Council of the city of Titusville, etc.: That Council may appoint an officer to be known as City Manager who, under the direction of the Superintendents of the various City Departments and the Council, shall have general supervision over and direction of the administration of the City's affairs. Said appointee to hold office until removed by Council and be paid the sum of $75 per month, in addition to salary as City Engineer.

Sec. 2. The City Manager shall see to it that the laws and ordinances relating to the City and its affairs are enforced; that the employees in the various departments faithfully and efficiently perform their duties and that the property of the City is properly cared for.

Sec. 3. The City Manager shall have power to purchase necessary material and supplies for the City where the amount involved does not exceed $25. He shall carry out the instructions of Council and of the Superintendents of Departments, and shall recommend to Council for appointment necessary servants and employees and for dismissal all unnecessary and inefficient servants and employees. Amounts in excess of $25 must be advertised for and bought on contract, by him.

Sec. 4. The City Manager shall, when requested, attend meetings of Council and report, in writing when requested, on any matters pertaining to the City's affairs, and shall, from time to time, recommend measures for its welfare.

Sec. 5. The City Manager shall take the oath required by law of municipal officers, and shall give bond for the faithful performance of his duties and the prompt accounting for funds and property which may come into his possession, in the sum of $3000, to be approved by Council.

The other ordinance mentioned by Mr. Bradley distributes "all the executive and administrative powers, authority and duties of the city" among the five departments and superintendents "prescribed by Act of Assembly" [Commission Government Act], as follows:

Sec. 1. . . . The Mayor, who is declared by the law the Superintendent of the Department of Public Affairs, shall perform and discharge the powers and duties expressly prescribed by law, and in addition shall have supervision and control over the office of City Solicitor, City Clerk, Sealer of Weights and Measures, the officers and employees assigned by ordinance to the Mayor's office and Police Department, and the property connected with any of them.

The Superintendent of Finance and Accounts shall perform and discharge the powers and duties expressly prescribed by law and in addition shall have supervision and control over the office of City Controller, City Treasurer, City Assessor,

and Collector of Taxes and License Fees, and over all the subordinate officers, employees, and property connected with any of them.

The Superintendent of Public Safety shall have supervision and control over the Fire Department, Health Department and all subordinate agencies affecting public health, boiler inspection, building inspection, removal of garbage, bill boards, fire-alarm system and all subordinate officers, employees and property connected with any of them.

The Superintendent of Streets and Public Improvements shall have supervision and control over all public improvements of every kind, street cleaning and repairs, sidewalks, sewers, new work and repairs, bridges, conduits, public utilities, office of City Engineer, and all subordinate officers, employees and property connected with any of them.

The Superintendent of Parks and Public Property shall have supervision and control over the City Hall, all public parks and public property not hereinbefore assigned, water department, markets, public library, City planning commission, street lighting and all subordinate officers, employees and property connected with any of them.

Sec. 2. The Superintendent of each department shall make and enforce such rules and regulations not inconsistent with law or ordinance as may be deemed necessary to secure efficient service in his department or the business in charge thereof.

Sec. 3. All Superintendents of Departments are the Agents of the Council only, and all their acts shall be subject to review and to the approval or revocation by the Council.

Those who have been following the city-manager plan closely will notice that Titusville departs from that plan as usually adopted in that the City Manager, instead of being the sole executive officer of the city, is under the direction of both the Council (or commission) as a whole and its individual members in their respective capacities as department heads. It will be interesting to see how this departure from what may be termed the model city-manager plan will work.—ED.]

Wind Pressures on Chimneys

Sir—In ENGINEERING NEWS, Mar. 5, 1914, George L. Jensen's article entitled, "The Design of a Built-in Brick Chimney," refers to "The Design of a Brick Chimney," by J. Norman Jensen, which article appeared in ENGINEERING NEWS, May 9, 1912. This reference calls my attention to some discrepancies in the earlier article.

I quote from Mr. Jensen regarding wind pressure on an inclined surface, as follows:

Referring to Fig. 1 (herewith reproduced—J. H.) let AB represent the total force blowing on the inclined surface. AB can be resolved into components BC and AC respectively, parallel and normal to MN. Since this surface is perfectly smooth, the component BC slides along and is lost. The normal component AC may in turn be resolved into components DC and AD respectively perpendicular and parallel to the direction of the wind. Component DC is neutralized by the corresponding component on the other side of the chimney. Component AD therefore represents that part of the original force which actually tends to overthrow the chimney.

He then proceeds to prove that $AD = w\cos^3\theta$, where "w = wind pressure per square foot on a vertical [normal?] plane." There is no apparent reason for stopping at D and assuming that AD is the active overturning force. Why not subject AD to a treatment similar to that applied to AB, obtaining as a residue a force $AD_1 = wl\cos^5\theta$? This process could be continued indefinitely, the final residual being $AD_\infty = wl\cos^\infty\theta = 0$. This equation is evidently absurd.

Again, the original force AB and the corresponding force on the other side of the chimney combined with the calculated necessary chimney resistance does not produce equilibrium. Evidently, Mr. Jensen should have found a counterbalancing force for BC rather than leave it "slide along and become lost."

Wind pressure upon any plane is produced by the direct impulse w_1 of the advancing particles and by the reaction w_2 of the particles repulsed. With perfectly elastic noninterfering, frictionless particles, impinging on a normal surface $w_1 = w_2 = \frac{w}{2}$, where w = unit wind pressure on a normal plane. In the case of an oblique plane the conditions are as represented in Fig. 2. AB represents the pressure due to impact and BC that due to repulsion. Under ideal conditions, $AB = BC$ and $\alpha = \phi$. The resultant force MN is $BD = wl\cos^2\theta$ acting normal to the surface. This is the actual force due to wind pressure on MN tending to overthrow the chimney (if the surface is part of a chimney wall).

In the case of a chimney symmetrical with respect to the direction of the wind there is a corresponding force $B'D'$ on the other side normal to $M'N'$ and equal to $BD = wl\cos^2\theta$. The resultant, $OE = 2\,wl\cos^3\theta$, of these two forces is the active overturning force due to the *pair* of surfaces, hence the equation $P = \frac{1}{2}\,OE = wl\cos^3\theta$ for one side, or $P = \Sigma wl\cos^3\theta$ for all sides.

This is the formula given by Mr. Jensen and is, according to the above theory, correct, but was not correctly derived by him. It should be noted that $P = \Sigma wl\cos^3\theta$ applies only to symmetrical chimneys or similar structures, and not to wind pressures in general. The general form of the equation would be

$$P = \Sigma_v wl\cos^2\theta$$

where Σ_v = vector summation of the forces on all surfaces. However, in the case of any probable chimney, the most unfavorable condition will be when the wind is parallel to an axis of symmetry, and the formula

$$P = \Sigma wl\cos^3\theta$$

is correct, notwithstanding its faulty derivation.

Perhaps more practical objection can be made to the discussion of the comparative merits of the different sections. Mr. Jensen says:

In the early part of this article it was stated that square chimneys are rarely built to great heights. This is accounted for by the fact that if the projected area of a square, octagonal, or round chimney is represented by the value F, then the total wind pressure on the chimney is taken at

For square chimneys	1.00 wF
For octagonal chimneys	0.71 wF
For round chimneys	0.67 wF

It is evident that considering wind only there is a decided gain in economy by using a round chimney.

The above quoted table may be extended thus:

TABLE I

Chimney	Wind pressure	Section modulus	Fiber stress
Square	1.00wF	1.00s	1.00f
Octagonal	0.71wF	0.65s	1.09f
Round	0.66wF	0.59s	1.12f

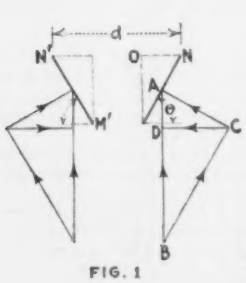


FIG. 1

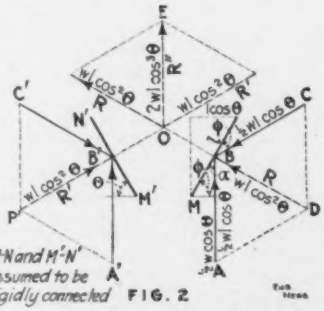


FIG. 2

where k and f are constants depending on the diameter and thickness of the wall. From this, it appears that considering *wind pressure* and *section modulus* a round section is the most *un*economical. However, such is not the case. A just comparison of the different sections must take into consideration the smoke openings and masonry areas. In Table II, a comparison is made between

TABLE II. COMPARISON OF WIND STRESSES IN EQUIVALENT SECTIONS

Section	Smoke area	Masonry area	Wind pressure	Section modulous	Fiber stress
Square: Side to wind.....	A	a	P	k	f
Square: Diagonal to wind....	A	a	0.71P	0.71k	f
Octagonal: Short dia. to wind....	A	a	0.78P	0.87k	0.90f
Octagonal: Long dia. to wind...	A	a	0.77P	0.80k	0.96f
Round.....	A	a	0.75P	0.84k	0.89f

sections having equal smoke areas and equal masonry areas. It will be seen that the round chimney is the most economical, but its advantage over the other forms is much less marked than indicated in Mr. Jensen's article. Other things being equal, a round chimney is to be preferred, but if conditions make a square chimney desirable, there is no need of being unduly prejudiced against that form.

It will also be noticed from the table that stress produced by a wind pressure normal to a long diameter of an octagonal chimney is 6% greater than when the pressure is normal to a short diameter, as treated by Mr. Jensen.

JULIAN HINDS.

Elephant Butte, N. M., Mar. 26, 1914.

Strength of Bolted Timber Joints

Sir—The tests on bolted joints described in ENGINEERING NEWS, of Mar. 19 and 26, 1914, are exceilent and fill a much needed gap. The bending in bolts certainly must be far less than that obtained by the method to which the author refers (load uniformly distributed over entire length of bolt). If this method were true, some structures which I designed would have failed long ago.

The author has omitted at least one book that has pointed out this very fact. I refer to "Structural Design," Vol. I, p. 43. We have there the common theory, erring, I believe, on the safe side; the true distribution of the stresses; and a theory which, while nothing more than an assumption, will agree roughly therewith. On this basis, a table has been computed from which I obtain (2) below.

(1) Average strength of ¾-in. bolts in double shear with wooden plates, all timber Douglas fir, 17,900 lb.

(2) Safe strength of same derived from tables, 1600 lb.

(3) Factor of safety, 11.

This is not far from correct practice if we consider variation in wood, the few tests made, and the fact that the joint was a small one. It will be noted that lower values per bolt are obtained on an average for the greater number.

HORACE R. THAYER.

Pittsburgh, Penn., Apr. 11, 1914.

The Fontaine Crossing-Frog and Locomotive

Sir—A continuous track or rotary rail section for track crossings, similar to that described in ENGINEERING NEWS, of Mar. 5, 1914, was invented by Fontaine about 35 years ago and tried in the railway yards at Toledo, Ohio, in 1882 or 1883. He was also inventor of the Fontaine locomotive which was tried in this country and Canada about the same time.

H. E. BUTTS.

428 Belonda St., Mt. Washington,
Pittsburgh, Penn.

[The Fontaine crossing was different from the Alexander crossing in several respects, and especially as to its operation. It had four revolving pieces of rail placed at the rail intersections, each operated by a connecting-rod from a central shaft which was operated from the tower. Our recollection is that in service the working parts wore and became loose. In the Alexander crossing, each revolving piece had a pinion on its under side, engaging with a horizontal rack bar. The Fontaine locomotive (with driving wheels resting on carrier wheels riding on the rails) was a mechanical monstrosity, the fallacy of which was very soon exposed.—EDITOR.]

Traffic through the Suez Canal

Sir—In order to "keep the record straight," I would like to add my bit of information in regard to the tonnage of vessels passing through the Suez Canal. Less than a month ago, I spent a few days at Suez, Port Said and Cairo, where I met officials of the Compagnie Universelle du Canal Maritime de Suez and was given by them the following official figures: Traffic that passed through the canal in 1908, 3795 vessels of a total of 13,633,283 net tons; traffic that passed through the canal in 1912, 5373 vessels of a total of 20,275,120 net tons; total receipts of the company in 1912, $26,585,865; net dividends paid in 1912, $33 on each ordinary $100 share.

To my mind, it is ridiculous to suppose that the Panama Canal will handle during the first few years after its opening anything like the traffic which now passes through the Suez Canal. The ocean highways will not be changed in a day. How many new ships are being built for the Panama route? Very few. The ships now in service on other routes are not likely to be transferred to the new isthmian waterway in a day or a year.

It may be interesting to note in this connection that on my recent circumnavigation of the globe I saw the American flag flying upon two vessels. One was a four-mast lumber schooner in the harbor at Aukland, N. Z., and the other was the yacht of an American millionaire in the harbor at Colombo, Ceylon. Great Britain's supremacy of the seas was to be seen everywhere.

W. D. HORNADAY.

Austin, Tex., Apr. 6, 1914.

The Old Walls of Nanking, China, will be torn down in the interest of commerce, according to a recent cable dispatch from Shanghai. The walls are more than 20 miles in circumference, and vary from 60 to 80 ft. in height, and for the greater part can accommodate two carriages abreast along the top. They were completed in 1390 by Hung Wu, the founder of the Ming Dynasty.

A Contractor's Claim for Extra Allowance

A claim for extra allowance has been made by I. J. Smith Co., Inc., contractor for the Mayo Bridge, Richmond, Va., on the ground that the advertisement for bids on the bridge laid down a certain rock line under the river which was far above any elevation of actual line as was afterwards found in the construction. The claim is for $48,816.41, which is the amount the contractor states was required to do the extra work. The City Engineer, Charles E. Bolling, refuses to allow the claim, but has reported to the Administrative Board of the city that a fair valuation for the work would be $12,049.74. It is the opinion, however, of the City Engineer that neither the larger or the smaller claim is legal because (1) the foundation line given in the advertisement made no pretense of being accurate, and (2) the required formal approval of extras was not procured at the time the work was being done.

In the first invitation for proposals for the construction of the bridge, there was given a plan showing the location of the bridge, the profile of the bed of the river and the island separating the two channels of the river, and on this profile the bottom of this river was marked "rock" and the island was marked "earth." The advertisement inviting bids set forth the following:

> Information as to location of site and profile of present conditions for submission of plans will be furnished upon application. Persons submitting designs and bids are advised to examine the location, to judge for themselves the existing conditions.

The Smith company submitted bids on several designs, one of which was accepted. This bid of $224,734, had an attached list specifying itemized prices for such extra work as block paving on the roadbed construction of the double-track railroad line, etc., but contained no itemized bid or statement made in proposal for any extra work of any kind below the line as shown on the profile furnished. All other items of any kind were distinctly specified.

After about three months of work, the contractors wrote to the City Engineer calling his attention to the fact that they had gone a certain depth below the profile as originally shown and had not reached bedrock and requested instructions as to what they should do. He gave them orders to carry the foundation to solid rock and they so proceeded. At the time, however, the City Engineer states that no agreement was made between the contractor and the engineer as to any amount to be paid for extra work, although the contract as signed contained the following clauses:

> The contractor must be prepared to do any work resulting from modifications that may be ordered by the engineer. If such work entails extra cost or expense to the contractor, the amount of such cost must be ascertained before commencing work and the amount of said work shall be agreed upon in writing between the engineer and the contractor before commencing the work. This agreement as to the amount to be paid shall be final. . . .
>
> No claim shall be allowed for any alleged extra work unless same shall be done in pursuance with a written order from the City Engineer, at or before the first payment after the alleged extra work is executed, it being agreed by the parties hereto that all work of whatever character, failed to be claimed as above stated, shall be held to be work required by this contract.

The following clause in the specification defines the status of the profile as given in the advertisement:

> The foundation for the abutments and piers must conform to the dimensions shown on the plan. The profile of the ground as shown on the plan is believed to be approximately correct, and is not guaranteed and the contractor will receive no extra payment for the removal of material that is required to be removed in due to the variation of the actual profile of the ground from that shown on the plan. . . . All foundations will be on rock.

The City Engineer gives as his opinion that it is believed that the bid submitted to the City by the contractor was intended to cover a completed piece of work; that the contractor did have to go to a greater depth than shown on the profile in order to get a proper foundation is true, but that it was up to them to make provision for this in the bid which they submitted for the completed contract.

The case is now under consideration by the Administrative Board of the City of Richmond.

Flood Prevention on the Yellow River in China

We described in our issue of Sept. 25 last, the plans for flood control on the Yellow River in China, prepared by Charles D. Jameson, acting for the American Red Cross Society. The carrying out of these works has now been entrusted, it is stated, to the firm of J. G. White & Co., of New York City.

The contract made by the Chinese Government with the Red Cross Society on Jan. 30, 1914, is published in full in the *Far Eastern Review* for February. We print the most important portions of the contract as follows:

> The Government of the Republic of China engages itself to allow the American National Red Cross, or its representatives, or successors, a period of one year from date for the purpose of preparing and effecting a Hwai River Conservancy Loan. The amount of this loan is to be $20,000,000 gold, or such sum as may be found necessary, after complete surveys have been made, to carry out the work of improving the water courses embraced in the Hwai River district, together with the contemplated outlets to the sea and the Yangtze River. If after the above conservancy work has been in progress for some time, it shall appear that the original loan is insufficient to provide for its completion; then, after complete investigations as to the requisite amount have been made by the Engineer-in-Chief, the Director General of the National Conservancy Bureau, upon approving the report submitted by the Engineer-in-Chief, shall approach the American National Red Cross, who will continue to use their good offices for increasing the loan, on terms mutually satisfactory at the time of such increase, to such an amount as will render possible the completion of the Hwai River Conservancy works as herein delimited.
>
> The loan shall be a Government of the Republic of China Gold Loan, bearing interest at the rate of 5% per annum and shall be secured as follows:
>
> (a) All government revenue derivable or now derived from government lands in the Conservancy Area as defined in Article II, and Appendix A, and also all additional revenues which may in the future accrue to the Government of the Republic of China as a result of the conservancy work, which shall include revenue from the sale or lease of reclaimed lands, as well as special conservancy, taxes, to be levied by the Government of the Republic of China on all lands benefited by the Conservancy work; also all tolls levied for the use of the Grand Canal within the Conservancy Area.
>
> (b) Should the above revenues and taxes derived by the Government of the Republic of China be insufficient to meet the payments of the interest and principal of the loan when they fall due, the Government of the Republic of China undertakes to repay in full both principal and interest on their due dates, with revenue derived from other sources.
>
> The issue price of the bonds shall be fixed by agreement between the Government of the Republic of China and the American National Red Cross, or its representatives, or successors, in accordance with the most favorable market price of the similar obligations of the Government of the Republic of China, such as bonds for railway construction, at the time of signing the loan contract. The price payable to the Gov-

ernment of the Republic of China shall be the actual rate of issue to the public less an equitable amount for bankers' commissions, flotation charges and stamps.

The Government of the Republic of China expresses its desire to trust the American National Red Cross to secure an engineer of at least five years' experience in the United States in river conservancy work of the first magnitude and of the highest professional reputation, for the post of Engineer-in-Chief of the Hwai River Conservancy work, who shall be entrusted with the preparation of definitive plans for the engineering work and shall be in charge of all the works in the Conservancy Area. As an evidence of its good intention to assist the Republic of China the American National Red Cross shall designate for appointment by the Government of the Republic of China, an engineer possessing the qualifications desired by the Chinese Government as stated above. In order to give evidence of American fairness and strengthen the confidence felt in the Chinese Government any consulting engineer representing the Director General of the National Conservancy Bureau who shall be under orders to inspect the progress of the works of the Hwai River Conservancy and the other conservancy works in the Conservancy Area as delimited in Appendix A, shall be afforded reasonable facilities for such inspection, in the same way that he is assisted in the inspection of all the other works undertaken by the National Conservancy Bureau.

The construction work shall be carried out under a percentage contract, and the construction company selected to carry out the work shall have the approval of the Government of the Republic of China and of the American National Red Cross, or its representatives or successors. All subcontracts of a nature to be specified in the final agreement, which may be let out by the construction company for the prompt prosecution of the work, are to be made on the basis of public tender.

If within the Hwai River Conservancy Area there are engineering works of lesser magnitude that, either from the standpoint of conservancy or water communication, demand immediate action and necessitate the preliminary advance of one or two million dollars gold, then the American National Red Cross, or its representatives or successors, actuated by a friendly purpose to assist China, agree to use its good offices, after receiving the representations of the Government of the Republic of China, to secure at the earliest possible moment an advance to the amount required, said advance to be repaid from the large loan when made.

All arrangements for the efficient handling of disbursements and receipts and for the mutual protection of the Government of the Republic of China and the bondholders shall be settled by negotiations and embodied in the final agreement. General lump sum appropriations from the proceeds of the loan must first receive the sanction of the Director General of the National Conservancy Bureau but all payments made therefrom shall be made only upon joint approval by the Managing Director and the Engineer-in-Chief.

As soon as possible after the signing of this Memorandum the two parties shall appoint delegates with full powers to negotiate and conclude a Final Agreement subject to the approval of their principals. When the expiration of the time covered by this Memorandum has arrived should either party thereto be unable to fulfill its engagement it shall become of no effect.

PAUL S. REINSCH,
Envoy Extraordinary and Minister Plenipotentiary of the United States of America.
CHANG CHIEN,
Director-General of the National Conservancy Bureau.

Progressive Work in Dayton City Government under a City Manager

The Bureau of Municipal Research has just issued a leaflet summarizing briefly some of the important movements set on foot in Dayton, Ohio, during the first three months of the City-Manager system of government. The leaflet contains so many suggestive hints relative to lines of work which it is now deemed proper for a city government to undertake but which would have been deemed utterly outside its functions a few years ago that we reprint the list as follows:

Jan. 3.—Began the installation of an accounting system adequate to provide balance sheets of all city accounts, and provide exact control over public funds.

Jan. 5—Resolution limiting city expenditures to within actual revenues.

Jan. 8—Provided for the purchasing of all city supplies by a central purchasing agent.

Jan. 13—Engineering firm engaged to make survey of needs, and to recommend steps necessary to secure an adequate water supply. Blowing new wells and tying them into water supply.

Jan. 14—Weekly school for policemen started, giving instruction in ordinances and character of duties; target practice and duels.

Jan. 16.—Civic workers league formed to secure the cooperation of children in a city-wide clean up.

Jan. 17—Consulting engineers employed to investigate best means to dispose of garbage and refuse.

Jan. 18—Commission appointed to organize summer baseball leagues among school boys.

Jan. 19—Began periodic flushing of downtown streets.

Jan. 22—Duties of a city complaint station extended to include complaints of every character.

Jan. 23—Collection of ashes and rubbish resumed, after year of non-collection throughout the city.

Jan. 26—Held first public hearing on the estimates of city expenditures.

Jan. 27—Began fire prevention inspection of every residence and store building in Dayton.

Jan. 29—Adequate clothing, shoes, socks, etc., supplied to prisoners in the workhouse. Five district city physicians appointed for gratuitous service to those unable to pay.

Feb. 1—Secured thorough snow removal on downtown streets and directed police officers to require cleaning of sidewalks by householders.

Feb. 2—Arranged to provide work for such needy cases as would be referred to the city by associated charities.

Feb. 6—Commission named to draft a building code.

Feb. 12—Conference with railroad executives and agreement to minimize crossing blockades—street railway company reporting daily of crossing delays.

Feb. 15—Street-car companies offer better ventilation of street cars.

Feb. 16—City commission passed first city budget to show salaries and costs in detail, and to group expenses according to uniform classification.

Feb. 17—Conference with health officers of Miami Valley to promote efficient control of communicable diseases and clean milk supply.—Civic music league inaugurated. Choral societies being formed in the several parts of the city.

Feb. 20—Commission appointed to revise and bring up to date the traffic ordinances of the city.

Feb. 21—Free legal aid bureau formed to give advice to citizens unable to employ an attorney.

Feb. 24—Seven additional patrolmen added to police force to patrol residence districts during the day.

Feb. 25—Arranged for inauguration of "police women" service.

Feb. 26—Unification of the visiting nurses of the city under the direction of the Welfare Department.

Mar. 1—Upon request, street-car companies employ permanent switch tenders at central street intersections, to facilitate traffic movement.

Mar. 4—Interested boy scouts in leading clean-up movement, organized play and garden development.

Mar. 6—Work of the Playgrounds and Gardens Association united with the part and playground activities of the city.

Mar. 14—Free baby clinic at office of the division of health established.

Mar. 18—City secures vacant lots for those desiring gardens, and arrangements made for free plowing.

Mar. 20—First bi-monthly meeting with dairymen held to promote safer milk supply.—Began rigid enforcement of traffic ordinance—"safety first."

Mar. 26—School of instruction for playground leaders opened.

Mar. 28—Authorized the appointment of a Civil Plan Commission to pass on platting and recommend plans for civic improvements.

Mar. 29—Authorized the appointment of a commission on the renaming and renumbering of streets.

Mar. 30—Began publicity on anti-fly and reduction of infant mortality campaign.—Adopted new uniforms and standards for the division of police.

Mar. 31—Installed unit cost system on rubbish and ash removal, and garbage collection.—Began installation of unit cost system on live stock in division of fire.

Apr. 1—Began installation of unit cost system in the municipal garage.

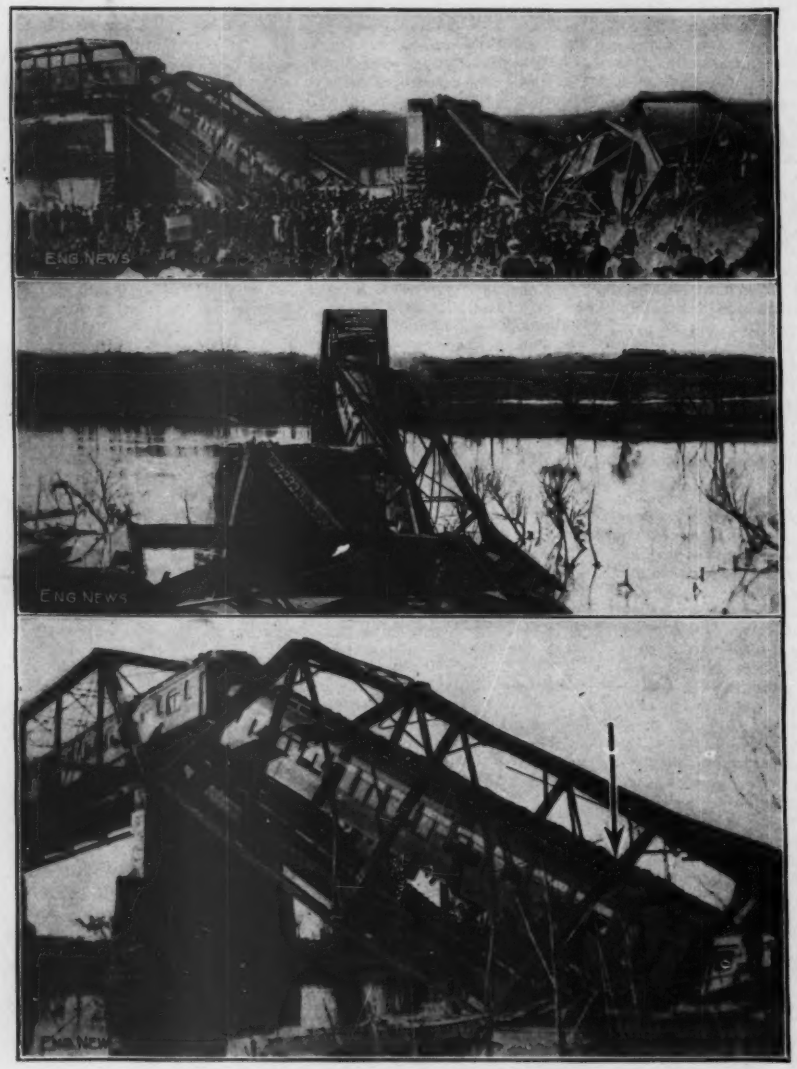
Apr. 4—Installed unit cost system in city prison, municipal lodging house, and workhouse.

The Attica Bridge Wreck

In the matter of the remarkable wreck of the Wabash River bridge of the Wabash R.R. at Attica, Ind., definite authoritative data are given herewith which will be useful in figuring on the structure.*

The drawing, Fig. 4, with stress tables attached, gives the truss dimensions and makeup of the two wrecked spans, and the stresses under the freight locomotive and the passenger train involved in the accident. These data are from A. O. Cunningham, Chief Engineer, Wabash R.R., St. Louis. The stresses produced by the freight engine were successfully borne by the bridge even though one end-post of the 108-ft. easterly span had been bent badly by a derailed car-truck, whereas the stresses produced by the passenger train, *though lower*, bore down the bridge. The floor-beam and stringer stresses (not reproduced) are moderate, though relatively higher than the truss stresses.

The figures bring out clearly that there is nothing in the computed stresses to account for a normal failure. The mystery of why the span held under the freight engine and failed under the passenger engine is not explained by the stresses.



FIGS. 1-3. THREE VIEWS OF THE BRIDGE WRECK ON THE WABASH R.R. AT ATTICA, IND.

(Upper view: Looking north at the two easterly spans. Middle view: Looking west across the Wabash River. Lower view: The second span, wrecked by impact of passenger car against end-post.)

CHIEF ENGINEER'S ACCOUNT OF THE ACCIDENT

Mr. Cunningham gives the following account of the accident:

On Sunday morning, Apr. 5, just before noon, a westbound freight of about 50 cars was passing the depot at Attica when the rear truck of a refrigerator car jumped the track and proceeded onto the Attica bridge. In some inexplicable manner, the truck was released from the car just as it got onto the bridge, making a complete horizontal revolution and striking the end-post on the south side of the bridge sideways with such force that the end-post was bent laterally about 12 in., shearing many rivets in the cover plate and splitting the cover plate for a distance of 8 ft. on one side and 4 ft. on the other, at the junction of the angle with the cover plate. The train proceeded very nearly over the bridge, so that the derailed car was in the center of the second span from the east end before the train came to a stop, at which time the train became uncoupled, and the rear end of the refrigerator car rested on the rail. The train was uncoupled from the refrigerator car, the head end proceeding to the next town, Williamsport, a distance of about three miles; and the rear end was removed by the engine of the wrecking train. As soon as the head end of the train had been put in a side track at Williamsport, the engine returned to the bridge and pushed the car, after it had been backed up on a cross-tie and the rails had been greased, over the damaged span without any appreciable further damage to the span.

It was assumed by the Supervisor of Track that, because the bridge held this engine, which is of the heaviest class of engines on the railroad, the passenger train (to which a lighter engine was attached) could safely cross the bridge. However, this was an error in judgment, and when the passenger train had arrived at a point so that the engine was very nearly off the bridge, the east span collapsed, throwing the engine down the embankment and stopping the train suddenly; the rear end of the train, coming forward and striking the tender of the engine, buckled out to the northward, carrying the second span from its bearing on the pier and practically wrecking it. The position of the train was as follows:

The engine was on the south side of the abutment, the tender also on that same side, but in a diagonal direction toward the north. The baggage car lay diagonally across the bridge, its front end against the tender and its rear end on the north side of the first pier from the east end and attached to the combination car which followed. To the rear of the combination car was a coach which stood at an incline, and half of the longer span remained on the westward pier. The sleeping car and dining car which followed remained on the track on the third span. All the cars remained in a vertical position, and all those interviewed who were in the wreck said that the spans gave way very slowly.

*The adjoined photographs, Figs. 1 to 3, from Prof. Albert Smith, Purdue University, supplement his account of the accident printed in our issue of Apr. 16.

No damage was done to the cars on account of the fall, but a certain amount of damage was done to the roof of the combination car due to the fall of one of the posts on the roof.

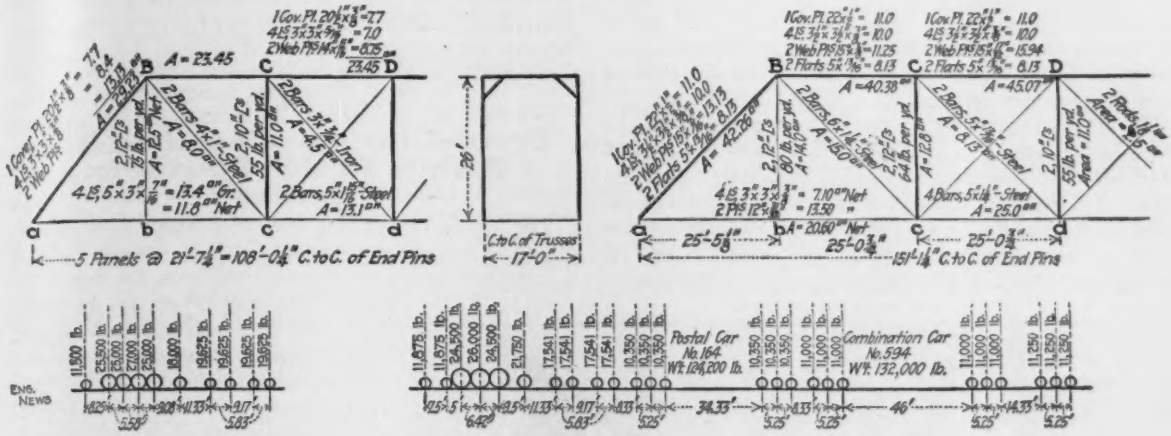
The work of clearing the wreck was commenced Monday morning, the steelwork of the bridge being blasted at the joints so as to be removed quickly; the cars were rolled over to one side by the wrecking derricks and a temporary bridge was constructed of piling and stringers, which at the present time is carrying the track.

The steelwork of the bridge and the position of the coaches made it very difficult to construct the temporary bridge, so that it took from Monday morning to Friday night to complete the temporary bridge.

Mr. Cunningham directs especial attention to the fact that the second span is lying north of its pier. This, he says, shows that the second span was thrown from the abutment on the north side of the bridge and failed because of this, and not on account of any defect in the bridge.

We have to add to the above account that the drawing in our issue of April 16th, which showed the position of the wrecked cars, was correct only as to plan, the elevation being evidently in error. The notes given in the present article will enable the sketch to be corrected.

A Commission-Manager Charter for Olean, N. Y., was passed by the New York State legislature and must be submitted to popular vote within a short time. A commission of five members, elected for two years, will choose one of its own number as mayor and will also appoint a city manager—who need not be a resident of Olean. The city manager will not have as full powers as under the ideal commission-manager plan, for the commission will appoint a city clerk to serve as head of the department of finance and a treasurer and also auditor, besides which the commission will act as a board of health and appoint a health officer. The city manager will be executive head of the division of police and fire, and will appoint police and fire chiefs, who will have a large measure of control of the men under them. The charter provides for the initiative, the referendum and apparently for the recall, besides nomination of commissioners by petition, the elimination of the primary and preferential voting.


5 Panels @ 21'-7½" = 108'-0¼" C. to C. of End Pins
C. to C. of Trusses
17'-0"
25'-5½"
25'-0¾"
25'-0¾"
151'-1¼" C. to C. of End Pins
Postal Car No. 164 Wt. 124,200 lbs.
Combination Car No. 594 Wt. 132,000 lbs.
ENG. NEWS

STRESSES IN 108-FT. TRUSS (EAST END SPAN)

Under freight locomotive, K1, without train-load

Member	aB	Bc	Cd	Bb	Ce	ac	B-E	cd
Dead load	47,000	23,400	0	14,700	3,400	30,000	45,400	45,400
Live-load	148,500	94,800	45,650	83,600	36,600	95,000	138,100	138,100
Total	195,500	118,200	45,650	98,300	40,000	125,000	183,500	183,500
Area	29.23	8.0	4.5	12.5	11.0	11.8	23.45	13.1
Unit stress	6,700	14,800 (Steel)	10,100	7,850	3,640	10,600	7,820	14,000 (Steel)

Under passenger locomotive No. 672 (class J1) with postal car No. 164

Member	aB	Bc	Cd	Bb	Ce	ac	B-E	cd
Dead-load	47,000	23,000	0	14,700	3,400	30,000	45,400	45,400
Live-load	139,800	86,400	40,620	73,650	32,600	93,200	133,500	133,500
Total	186,800	109,400	40,620	88,350	36,000	123,200	178,900	178,900
Area	29.23	8.0	4.5	12.5	11.0	11.8	23.45	13.1
Unit stress	6,380	13,700 (Steel)	9,000	7,060	3,270	10,440	7,630	13,650 (Steel)

STRESSES IN 150-FT. TRESS (SECOND SPAN)

Under freight locomotive K1, without train-load.

Member	aB	Bc	Cd	De	Bb	Ce	Dd	BC	CE	ae	cd
Dead-load	88,600	53,100	17,700	—17,700	19,600	18,500	+6,960	100,600	111,000	61,600	100,600
Live-load	193,100	142,500	92,300	49,000	88,500	66,500	35,300	213,500	222,700	135,300	213,500
Total	281,700	195,600	110,000	31,300	108,100	85,000	28,340	314,100	333,700	196,900	314,100
Area	42.26	15.0	8.13	2.5	14.0	12.8	11.0	40.38	45.07	20.60	25.0
Unit stress	6,660	13,050 (Steel)	13,500 (Steel)	12,500	7,720	6,640	2,580	7,780	7,380	9,560	12,550 (Steel)

Under passenger locomotive No. 672 with actual train-load

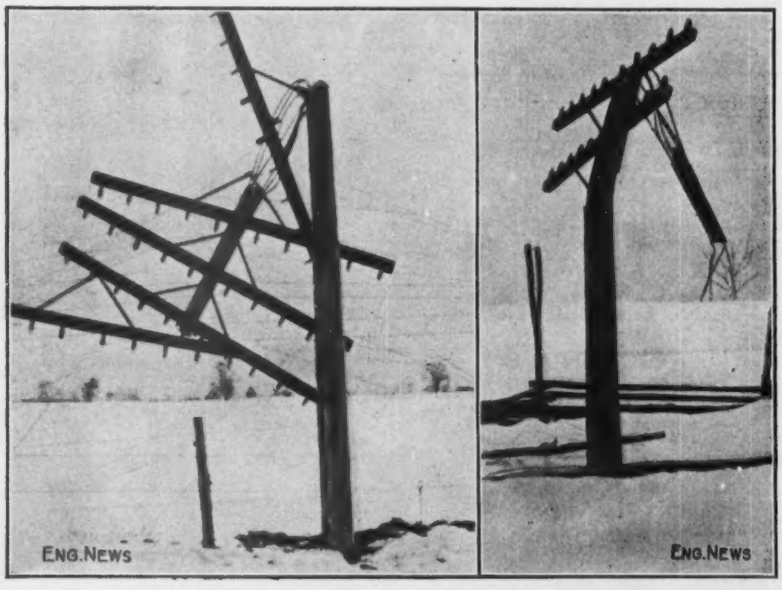
Member	aB	Bc	Cd	De	Bb	Ce	Dd	BC	CE	de	cd
Dead-load	88,600	53,100	17,700	—17,700	19,600	18,500	+6,960	100,600	111,000	61,600	100,600
Live-load	195,100	138,500	86,800	42,500	79,400	62,550	30,600	211,000	226,000	137,000	211,000
Total	283,700	191,600	104,500	24,800	99,000	81,050	23,640	311,600	337,000	198,600	311,600
Area	42.26	15.0	8.13	2.5	14.0	12.8	11.0	40.38	45.07	20.60	25.0
Unit stress	6,720	12,800 (Steel)	12,850 (Steel)	10,000	7,100	6,300	2,150	7,700	7,480	9,660	12,500 (Steel)

FIG. 4. SECTIONS OF WRECKED SPANS, WABASH RIVER BRIDGE, ATTICA, IND., WITH TABLES OF STRESSES UNDER ACTUAL LOADS OF APRIL 5

Failure of Concrete Poles During Blizzard

In ENGINEERING NEWS, Mar. 12, 1914, p. 587, there was a brief article noting the superior behavior of designed (both concrete and steel) poles across the Hackensack Meadows during the very severe blizzard of the first week in March. Since then, James Logan, County Engineer, of Burlington Co., N. J., has called our attention to the fact that farther south in New Jersey, some reinforced-concrete poles did not stand up so well under the blizzard conditions, although it may be noted that the poles in question were designed for lighter loading than they were carrying at the time of their failure.

The line in question is located over a length of 20 miles in the vicinity of Mt. Holly, N. J., and is a part of the New York-Washington line of the American Telephone & Telegraph Co. In this section, there are 52 concrete poles and 780 wooden poles, the concrete poles being scattered among the wooden poles with the idea of getting data upon their behavior under extraordinary conditions. In fact, the concrete poles were placed and designed mainly as an experiment. Of these 52 concrete poles and 780 wooden poles, 25 concrete and 43 wooden poles suffered some injury during the blizzard of Mar. 1-2. The accompanying photographs show two poles in the immediate vicinity of Mt. Holly, and are typical of the failures.



FIGS 1-2. HOLLOW REINFORCED-CONCRETE POLES, WHICH FAILED DURING THE MARCH BLIZZARD, 1914.

In this section of the line, about 3 miles in length, there were eight reinforced-concrete poles interspersed irregularly among something over 100 wooden poles. All of the eight concrete poles were broken, two at approximately the ground line, the other six at points ranging from about 8 ft. above the ground line to a point about 17 or 18 ft. above the ground line, which was just below the level of the lowest crossarm. These poles carried from 41 to 43 wires.

The poles were square in cross-section and hollow in the center. The vertical reinforcement consisted of a number of ½-in. deformed bars, located in or near the corners, the number of bars varying to care for the stresses of different elevations. The horizontal reinforcement consisted of steel bands aided by a spiral wrapping of No. 14 wire, at points where vertical reinforcing bars were dropped. The concrete wall was approximately 1½ in. thick, and was made from concrete in which the coarse aggregate consisted of ¼-in. broken stone chips. Each of the poles was designed to withstand an ultimate horizontal load of about 2000 lb., applied at the center of the crossarm system; that is, at a point approximately 21 ft. above the ground line.

Sand-Clay vs. Macadam for Roads in the Southern States

The highly satisfactory results obtained in several of the southern states with sand-clay surfacings on well drained and otherwise improved roadbeds, has led to the belief that such roads are not only some ten times cheaper in first cost than macadam, but are much more economical to maintain and are just as satisfactory for all ordinary traffic. According to T. F. Hickerson,* Associate Professor of Civil Engineering at the University of North Carolina, the construction cost of sand-clay roads, exclusive of grading, varies from $300 to $1200 per mile for a surfaced width of 9 ft.; and that the estimated annual cost of maintenance with the occasional use of a road drag varies from $10 to $30 per mile.

Prof. Hickerson says further that this type of construction has indeed solved the problem of better country roads in the South without an excessive expenditure of money; for, when properly constructed, these roads are sufficiently rigid to bear ordinary traffic, are not seriously softened in wet weather, and are easily maintained in shape by the use of a road drag.

A study of existing dirt roads which were particularly noticeable for their good qualities has developed the fact that a natural mixture of sand and clay, or gravel and clay, often found in abundance in the cultivated fields alongside the road, makes an excellent surfacing material, when properly worked. These are known as "top-soil" roads, and this method of surfacing, according to Prof. Hickerson, had its origin from the fact that many stretches of road, where the original top soil had never been disturbed, remained in good condition at all times and frequently showed very little wear after a century of use.

In conclusion, Prof. Hickerson stated that the sand-clay or top-soil roads in the South might be the equal of, if not superior to, the ordinary macadam. Experiments in

*See paper read at the annual meeting of the American Association for the Advancement of Science, Atlanta, Ga., Dec. 29, 1913-Jan. 3, 1914.

TABLE I. SUMMARY OF ROAD HISTORIES AND ANALYSES

Sample No.	106	108	124	150	215	223*	272*	369	416*	501	282*
Character of road service:											
In dry weather	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Medium
In wet weather	Soft	Soft	Soft	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Soft
In prolonged wet weather	Cuts 2"-6"	Cuts 2"-4"	Cuts 1"-4"	Cuts ½"-1"	Hard	Hard	Cuts 1"-2"	Cuts ½"	Cuts ½"	Cuts ½"	Cuts 6"-10"
In freezing weather	Cuts 2"-6"	Cuts 2"-4"	Cuts 1"-4"	Cuts ½"-1"	Cuts ½"-1"	Cuts ½"-1"	....	Cuts ½"	Cuts ½"	Cuts ½"	Cuts 6"-10"
Frequency of re-shaping: Times per yr.	10-20	10-20	15-25	None in 4 yr.	None in 3 yr.	None in 4 yr.	None in 8 mo.	None in 3 yr.	None in 7 mo.	None in 3 yr.	2-4
Sand No. 10, percentage	12.5	....	....	6.3	....	34.0	....	7.2	1.5	10.0	....
Sands Nos. 20-60 percentage	32.8	32.7	41.0	48.0	53.9	46.2	32.3	45.0	57.9	50.2	23.2
Total sand, percentage	50.0	50.9	60.0	69.3	71.5	51.5	52.6	63.8	65.3	66.8	51.7
Total clay, percentage	50.0	40.1	40.0	30.7	28.5	48.5	47.4	37.2	34.7	33.2	48.3

Notes:—*Data for No. 223, based on roads built near Augusta, Ga. No. 272, Road in use 8 months at time of report. No. 416, Road in use 7 months at time of report. No. 282, practically an earth road.

the use of glutrin and certain light oils indicate that sand-clay can be treated just as effectively as waterbound macadam for the prevention of dust and the destructive action of water.

Probably the most complete and valuable study of sand-clay roads which has thus far appeared in print is the paper "An Investigation of Sand-Clay Mixtures for Road Surfaces," by John C. Koch, read at the Mar. 4 meeting of the American Society of Civil Engineers and published in the February *Proceedings* of the Society. Mr. Koch examined a number of sand-clay roads in Georgia, took samples of the road surfaces and analyzed these samples in the laboratory. His objects were to determine:

(1) The proper proportions of sand and clay in sand-clay mixtures to yield the best results, namely, durability in all weathers and absence of mud and dust.

(2) The limits between which the proportions of the two materials could vary without affecting seriously the quality of the resulting road surface.

(3) The effect of varying proportions of different sizes of sand in such mixtures.

(4) An approximate field method for the examination of soils, to determine their suitability for road surfacing.

Following out this scheme, he made tests of the properties of the materials, outlining the laboratory procedure so that the tests can be duplicated by others. In conclusion, he gives some typical analyses and the histories of the roads from which the samples were taken. The accompanying Table I gives a summary of these data:

From these compilations, Mr. Koch makes the accompanying group analyses (Table II):

TABLE II. COMPARATIVE ANALYSES OF SAND-CLAY GROUPS

	Inferior limits %	Sand-clays average %	Superior limits %	Sand-clays average %
Sand total	52.6-60	56.3	63.8-71.5	67.6
Sand Nos. 20-60	32.3-41	36.6	45.0-57.9	51.4
Sand No. 100 and dust	10.0-17	13.5	4.1-13.8	8.9
Clay total	40.0-47.4	43.7	28.5-37.0	32.7

The principal differences between the two groups are that the total sand content in inferior mixtures averages 11% less than in superior mixtures, and the total quantity of sand from No. 20 to No. 60 in inferior mixtures averages 15% less than in superior mixtures. Mr. Koch draws the following conclusions:

(1) The total relative sand content, disregarding the size of the sand grains, is no criterion of the value of the material.

(2) The sand smaller than No. 60 is of little value in the mixture, that smaller than No. 100, except in very small quantities, is detrimental.

(3) The greater the proportion of coarse to fine sand the harder and more durable will the road surface be.

(4) For the best possible results with sand-clay mixtures, the sand smaller than No. 10 and larger than No. 60 should not be less than 45% nor more than 60%, by dry weight, of the entire sample. In addition, the sand smaller than No. 10 and larger than No. 60 should be composed of about equal parts of Nos. 20, 40 and 60. The total sand content should in no case exceed 70% by weight, of the total sample.

(5) Test cylinders of the sand-clay mixture, 1 in. in diameter and 3 in. long, should, when thoroughly dried in air bath at 100° C., take at least 2 min., when immersed in water at 21° C., to crumble down to the natural slope of the material, and preferably should take 6 min. If the cylinder fails in this test, it should be regarded with suspicion. If the sand analysis is poor and the cylinder test is also poor, the material is not worth using.

(6) Test cylinders, made from the clay removed from the sample, 1 in. in diameter and 3 in. long, should take at least 2 min. to crumble down to the natural slope of the material, when immersed in water at 21° C. If it fails in this test, but passes the test of the preceding paragraph, it may be used, but it indicates a poor quality of binder.

The best method of construction for natural mixtures or top soil, according to Mr. Koch, is to spread the material in a continuous layer 10 to 12 in. thick over the subgrade of the roadway, which has been previously leveled or brought to a slightly convex cross-section. The material should be spread as soon as delivered and not dumped in piles. After a sufficient quantity has been placed an ordinary road machine is drawn along the ditch line, cutting about 4 in. deep at the outside, and the blade is set so as to cast the material from the ditch against the edge of the sand-clay layer. After both sides have been thus shaped, the road machine, in successive passages, rounds up the cross-section of the sand-clay surfacing so as to give the proper crown to the roadway. Traffic compacts it without the use of a roller. Ruts in the new surface should be filled and a proper cross-section maintained by the occasional use of a road machine for a period of about two months.

Artificial mixtures should be used, Mr. Koch says, where there is a sand foundation and the clay may be hauled and the proper mixture made by disk plowing and puddling; on a clay foundation where the sand may be hauled and mixed as noted; and on a soil foundation where both sand and clay are hauled from separate sources and the mixture made on the ground.

Such roads have been built in many localities in Georgia for less than $500 per mile, and under heavy country traffic the repairs during a period of five years have not averaged $5 per mile per year. In a country subject to severe winters the roads would, of course, have to be practically rebuilt each spring, but even then it is believed that they would prove much more economical and satisfactory than waterbound macadam under heavy motor traffic.

The Wisdom of a Pioneer Road Builder—In the construction of roads, as well as in most other works of engineering, the greatest amount of credit is not, as a matter of course, due to him who produces the best kind of road; because, *however excellent the production may be, it is possible that its cost may have been so enormous, that, balancing on the one hand the advantage of a good road against the outlay of a disproportionately vast sum of money, the engineer after all,* instead of conferring a boon upon the country, may have inflicted a serious evil. ["The Practice of Making and Repairing Roads," by Thomas Hughes, Esq., Civil Engineer, London, 1838—Hughes was a contemporary and colaborer with MacAdam and Telford.—Ed.]

Some Interesting Features of the Recent Derailment on the New York, New Haven & Hartford R.R.

There were two features in connection with the derailment on the New York, New Haven & Hartford R.R. near Harrison, N. Y., Apr. 12,* of particular interest to engineers; one the guard-rail effect of a parapet wall on a masonry culvert, which undoubtedly prevented a much more serious accident; and the other the damage done to the catenary trolley wire system.

Guard Rail Effect of Parapet Wall

The accompanying view, Fig. 1, shows the parapet wall of a masonry arch culvert over a private road at the site of the derailment. The culvert is of a double-barrel arch type, made of large blocks of cut granite laid in cement mortar, with a parapet wall and coping about 30 in. above subgrade. It is evidently old, of more substantial construction than ordinary, and unusual in American railway practice in having the high parapet wall, although parapet walls are ordinary practice in Europe.

Fig. 1. Parapet Wall of Masonry Culvert at the Site of Derailment

The train which was derailed on Apr. 12 was eastbound on the outside track. The leading one of the two electric locomotives was evidently derailed about 1000 ft. before reaching the culvert, while running at a speed estimated at from 50 to 55 miles per hour. By the time the culvert was reached both locomotives and the two all-steel mail cars were probably running on the ties and headed fairly for the ditch.

Striking the parapet wall of the culvert a glancing blow evidently resulted in deflecting the derailed locomotives back upon the roadbed, on which they continued 400 or 500 ft. more before finally coming to a stop. Fig. 2 shows the effect upon the parapet wall of the culvert, which was leveled to subgrade. Large blocks of granite weighing at least two or three tons were thrown several feet laterally; yet it is apparent from an examination and from the view shown that the parapet wall played an important part in preventing the train from going over into the road below and piling up against the wing wall of the culvert.

While the above description of what happened is hypothetical, based on the appearance of track and structures, it is substantiated by an eye witness of the accident, quoted by the New York *World* as follows:

> As the train thundered on, the motor car in front made a heavy lurch just as it reached the bridge over the roadway. There was a crash. The heavy stonework of the bridge alongside of the track was ripped off and hurled to one side. Some of the stones 6 ft. long and 2 ft. thick were tossed down in the road.
>
> As the front motor hit the stones it seemed to leap in the air. Then it dropped on the roadbed again and with another lurch crushed into a steel upright of the catenary that holds up the electric wires that furnish power for the trains. The upright was torn clear of its stone base and it fell over. Then the engine lunged on into a second upright, which also came down. But the uprights on the other side of the track held up the cross pieces and the wires did not come down.

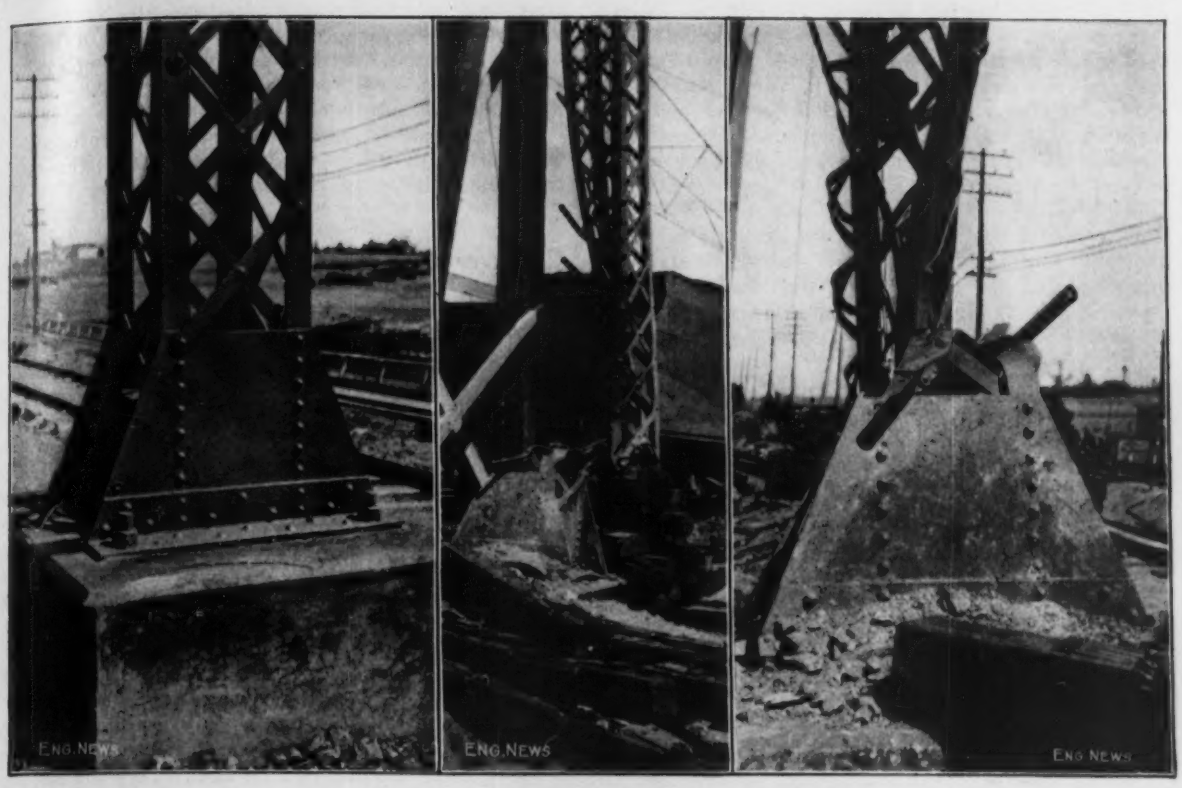
Damage to Overhead Wires

The conversion of the four-track main line of the New York, New Haven & Hartford R.R. from the outskirts of New York City to Stamford, Conn., to an 11,000-volt singe-phase electric traction system* was completed in

Fig. 2. Destruction of Parapet Wall by Derailed Train

*See "Engineering News," Apr. 16, p. 864.

*The distribution has recently been changed to 22,000 volts, this potential existing between feeder and trolley. An auto-transformer is connected between the two and a track connection tapped off at midpoint, so that 11,000 volts is secured between trolley and rails, as before.



Base of a Steel Tower — First Steel Tower Wrecked by Derailed Train

FIG. 3. CATENARY TROLLEY-WIRE TOWERS

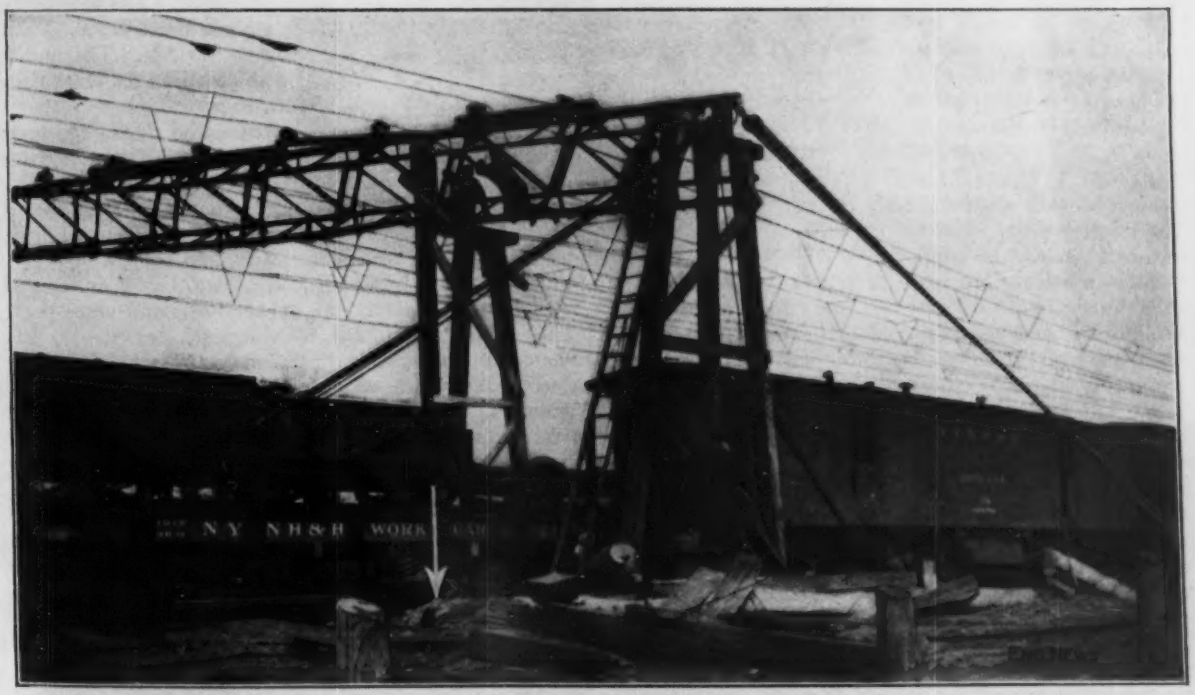


FIG. 4. SITE OF SECOND TOWER WRECKED BY DERAILED TRAIN; SHOWING TEMPORARY WOODEN SUPPORT FOR BRIDGE CARRYING CATENARY WIRES

1908, and there has been so far as we recall but one previous accident in which the catenary system was damaged. This occurred on July 16, 1908, when an express train was derailed near Greenwich, Conn. In this instance the trucks came off one of the cars and were thrown against one of the towers supporting the catenary system. The other towers were protected by being set in deep niches in a rock cut.

In the recent accident, the first tower struck was about 200 ft. beyond the culvert. It was evidently hit quite high and only a glancing below. One of these towers intact and this first one struck by the derailed train are shown in Fig. 3. In this case the overhead bridge and catenary wires did not collapse. The next tower was 300 ft. beyond—the regular spacing between bridges. All that was left upright of this tower is shown under the arrow in Fig. 4. Evidently all four bolts were broken off in the concrete. The second locomotive stopped over this point and the overhead bridge and wires fell on its roof.

The towers or posts are approximately 38 ft. high and 1 ft. 10 in. square. They are made of four 4x4x$\frac{7}{16}$-in. angles laced with 2¼x⅜-in. bars. Each tower rests upon a foundation containing about 9 cu.yd. of concrete. Four anchor bolts extend entirely through the foundation block and hold the base of the tower by means of heavy nuts. The cross-bridge trusses are 4 ft. 6 in. deep from back to back of chord angles and the two angles of each chord are spaced horizontally 1 ft. 10 in. b. to b. The upper chord angles are 6x3½x⅜ in. and the lower 4x3½x$\frac{5}{16}$ in.

Each of the two catenary cables which support the trolley conductor consists of extra high strength $\frac{9}{16}$-in. steel cables, composed of heavy strands. This steel has an ultimate strength of 200,000 lb. per sq.in. The completed cable has an ultimate total strength of 33,800 lb. The trolley conductor is No. 0000 B. & S. gage grooved copper wire, supported by the catenary cables at intervals of 10 ft. by means of equilateral triangular trolley hangers of various sizes.

Originally, the current collectors of the locomotives were in direct contact with the copper trolley conductor, but owing to the rapid wear of the copper wire a steel contact wire of the same size was added below the copper conductor and fastened to it at 10-ft. intervals between the triangular supports.

Anchor bridges are spaced every two miles. Each of these carry lightning arresters, transformers for operating the circuit-breakers and other apparatus for the block signals. These anchor bridges are equipped with automatic oil-switch circuit-breakers which open as soon as an extraordinary load comes on the trolley wires, so that in case of such an accident as the one on Apr. 12, the grounding of the trolley wires by contact with the steel locomotives and cars immediately cuts out the current on the two-mile section.

Extensions of the side towers above the cross-bridges are utilized for supporting the power transmission wires, which are carried on steel angle cross-frames bolted to the towers. The lower cross-arm is 5 ft. below the upper one. The breaking of these transmission wires in the recent accident was unattended with serious results to the train, but cut off the current from the electric zone west of the site of the accident. Electric traction was not restored for about six hours.

The catenary trolley system of the two westbound tracks was practically undamaged, and the erection of some temporary supports to carry the overhead bridges at the two wrecked towers was about all that was necessary to restore these wires to service.

In order to facilitate the operation of the wrecking cranes, the outside track on which they were operated was temporarily offset between 2 and 3 ft. to the right from under the center of the catenary wires.

Concrete Fence Posts on the San Pedro, Los Angeles & Salt Lake R.R.

The San Pedro, Los Angeles & Salt Lake R.R. is one of a number of railways using concrete fence posts somewhat extensively and for making these posts it has a plant of its own near Salt Lake City. It has already about 23 miles of fence of this kind, and about 10,000 posts were made and placed last season. For particulars of the posts and their manufacture, we are indebted to R. K. Brown, engineer of maintenance-of-way, at Salt Lake City, Utah.

The posts are approximately rectangular in plan, but with the sides tapering slightly and the back rounded. They taper from 5x5 in. at the base to 3x3 in. at the top. There are five fence wires, secured to the flat side of the post by galvanized tie wires passed around the back of the post and having the ends wrapped around the fence wires. The posts are 7½ ft. long, set 3 to 3½ ft. in the ground, and weigh 89 lb. each. They are spaced 16 ft. apart. For transportation, they are piled and stacked in the cars in much the same way as lumber, but they must be handled more carefully than wood posts. The cost averages a little over 21c. each, which does not cover interest on plant or depreciation. The investment in plant (bins, mixer, molds, etc.) is about $1000. Wood posts for the same work cost 14 to 21c. The anchor posts are 8 ft. long, 7x7 in. at both ends; the brace posts are 10 ft. long, 5x5 in. at both ends.

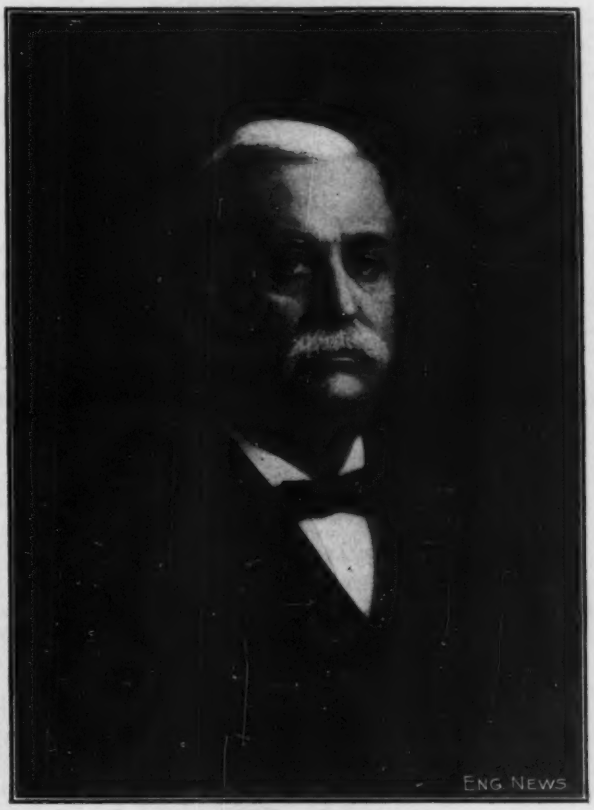
The concrete is a 1:6 mixture, the coarse aggregate being obtained from a gravel pit in which the proportions of sand and fine gravel make a very satisfactory combination for this purpose. The material is stored in elevated bins, with chutes to the mixer. The reinforcement consists of four strips of No. 18 hoop steel, ⅝ in. wide, the strips being 7 ft. 3 in. long, but ⅜-in. twisted steel bars are used in the anchor posts and brace posts. The concrete is mixed to a creamy consistency, and poured into a set of ten metal molds mounted on a light steel frame which can be vibrated or shaken by hand. When the molds are full, the concrete is struck off to a level surface and the frame is vibrated in a longitudinal direction, consolidating the material much more quickly than can be done by hand tamping.

The set of molds is then laid on level ground and the concrete allowed to set for 24 hours, when the posts are removed from the molds and stacked vertically in groups being allowed to season for 60 days before being used. The number of men is usually three, and with these 160 posts per day can be made. With five men and additional molds a larger number can be made, and the extra men can put in part of their time on other work.

These posts are of the D. & A. type, and the molds, vibrating frame, etc., were furnished by the D. & A. Post Mold Co., of Three Rivers, Mich.

Alfred Noble*

Alfred Noble, Past-President of the American Society of Civil Engineers, and one of the most distinguished of American engineers, died Apr. 19 at St. Luke's Hospital, New York City. Mr. Noble went to the hospital a fortnight ago to undergo an operation for gallstones. He rallied well from the operation but shortly afterward contracted pneumonia. The news of his sudden death comes as a severe shock to his many friends throughout the engineering world, few of whom had even heard of his illness. The funeral services were held Tuesday evening, April 21, at the cathedral of St. John the Divine, New York City.



A Noble

Alfred Noble was born at Livonia, Wayne County, Mich., Aug. 7, 1844. He was educated in the country district schools and at the village high school. In August, 1862, at 18 years of age, he enlisted in the 24th Michigan Infantry, and served continuously in the Army of the Potomac until the close of the Civil War in 1865. He then obtained a position as a clerk in the War Department at Washington, where for two years, he worked and studied and saved for a college course.

In the fall of 1867, he entered the sophomore class at the University of Michigan, where he graduated in civil engineering in 1870, although he was absent much of the time on engineering work, under the United States Engineer Department. After graduation, he continued in government engineering work, and for 12 years, he was in local charge of the improvement of St. Mary's Falls Canal and the St. Mary's River between Lakes Superior and Huron. This was at the time of the construction at the Soo of what was then the largest canal lock in the world.

Mr. Noble resigned from the government service in 1882 and for four years was engaged in bridge work in Louisiana and as General Assistant Engineer of the Northern Pacific R.R., mostly on bridge work. In the summer of 1886, he came to New York City, where for a year he was Resident Engineer of the Washington steel arch bridge over the Harlem River. He then went to Cairo, Ill., where he had charge of the erection of the bridge over the Ohio River under Morison & Corthell, Chief Engineers. Later, he was connected with the construction of the famous cantilever bridge at Memphis, Tenn., of which the late George S. Morison was Chief Engineer. From 1892 to 1894, he was Assistant Chief Engineer for other Mississippi River bridges under Mr. Morison.

As a member of the first Nicaragua Canal Commission, appointed by President Cleveland in 1895, Mr. Noble first came into national prominence. Two years later he was appointed a member of the United States Deep Waterways Commission. Since that time he has been engaged in private practice in New York City, except for the period from 1902 to 1909, during which he was Chief Engineer of the East River division of the Pennsylvania R.R. tunnels in New York City. Mr. Noble also served as a member of the Isthmian Canal Commission, from 1897 to 1900, and as a member of the International Board of Consulting Engineers of the Panama Canal in 1905.

As a consulting engineer, he was connected with many of the greatest engineering projects of his time, among them the sea wall at Galveston, Tex., to protect the city from a recurrence of the great flood of 1900, the Mississippi River bridge at Thebes, Ill., and many other works; but most of all the Pennsylvania R.R. improvements in New York City, with which he was identified from the start. He was also a consulting engineer of the Public Service Commission on the construction of the New York City subways.

In 1910, Mr. Noble was awarded the John Fritz Medal of the national engineering societies "for his notable achievements as a civil engineer." He was President of the American Society of Civil Engineers in 1903, an honorary member of the Institution of Civil Engineers of Great Britain, an honor held by no other American of his time, a member of the American Society of Mechanical Engineers, of the Western Society of Engineers and of the Engineers Clubs of Chicago and New York City.

It is pleasant to record that a name which will ever be remembered in the annals of American engineering is inherited by a son, Frederick C. Noble, who has already achieved notable distinction as an engineer, and who is now one of the five field division engineers in charge of the construction of the new subways under way in New York City.

An editorial appreciation of Mr. Noble's services to American engineering will be found on another page.

*A more complete biography may be found in "Engineering News," Jan. 29, 1903, p. 90, published at the time of Mr. Noble's election to the Presidency of the American Society of Civil Engineers.

A Conference on the Snow-Removal Problem

Over 100 city officials, engineers, contractors and others who have to cope with snow-removal problem, met in the Mayor's reception room, City Hall, Philadelphia, Apr. 17, in response to an invitation from Morris Llewellyn Cooke, Director of the Department of Public Works of Philadelphia, to participate in a snow-removal conference. The business meeting on Apr. 17 was preceded on the evening before by a dinner to the visiting delegates tendered by Mayor Blankenburg at the Union League Club.

A number of prepared papers were read and much fruitful discussion ensued. It was at once evident that the problem was one on which practically no one was posted except as regarded his own individual experience. The severe storms of the early part of the present year had been productive of much recent experience; the problems and difficulties were still fresh in the minds of those in attendance, so that the time was ripe to bring out much interesting and valuable data.

Flushing and Dumping Snow into Sewers—J. G. Hayes, Director of Public Works of Scranton, Penn., came forward as a strong advocate of the flushing method of snow removal from paved streets. He quoted cost data on Scranton work where the cost per cubic yard of snow removed was as low as 21c. It was shown, however, by subsequent discussion, that an adequate allowance for the cost of the water was not included. Pittsburgh, Penn., has also had much success with this method of snow removal, but according to J. F. O'Toole, Director of Public Works, the conditions are peculiarly favorable. The sewer grades are very steep and manholes are conveniently located.

During the past winter, some of the sewers of New York City were extensively used for snow removal, and a series of experiments were conducted to determine what sewers could be used for this purpose, the effect of the temperature of the water in the sewers, the rapidity with which the snow melted, the effect on the sewers, the damage to the sewers, if any. These experiments were referred to by William Goldsmith, Assistant Engineer of the Department of Public Works, Borough of Manhattan, and results will be published in the proceedings of the conference. These and other data presented at the conference tend to show that the snow is completely melted within 300 ft. of the dumping manhole.

There was much spirited opposition to the flushing method of disposal. It was claimed to interfere with traffic, to require large amounts of water for which some one had to pay, to silt up sewers with the sediment in the snow. The majority seemed to be convinced that flushing was not an economic method of disposal; but the dumping of the snow into sewers from wagons or sleds was approved where the sewers were large enough and had enough velocity to take care of the additional material. Special manholes were discussed, but it was generally agreed that the ordinary type was sufficient for snow removal purposes. F. H. Clark, Superintendent of Streets, of Springfield, Mass., said he had dumped snow in sewers for many years; 50 loads per hour with two men at the manhole was the record; he did not consider special manholes necessary.

Carting Snow by Contract—Snow contracts appear to be more of a gamble than any other form of municipal contract, under present methods. One great difficulty is the measurement of the loads or wagon capacities. In New York City, this work is done by the forces of the Sealer of Weights and Measures. Another problem discussed was to develop a system of checking loads so that the same load would not be paid for twice; it appeared that there was necessity for keeping tabs on the city inspectors as well as on the contractors. W. H. Connell, Chief of the Bureau of Highways, of Philadelphia, described his experience with the contract system of snow removal.

E. D. Very, Consulting Sanitary Engineer, of New York City, recommended the area method of paying for snow removal. He thought it was impossible to devise a load-checking system that could not be beaten. Capt. Mark Brooke, Assistant to the Engineer Commissioner of the District of Columbia, said that in the city of Washington teams and trucks were hired by the day and the snow removed by day labor at a cost of from 15c. to 35c. per cu.yd. J. C. Hallock, Deputy Chief Engineer, Department of Public Works, Newark, N. J., also advocated the hire of teams by the day as a less complicated and more efficient method than the elaborate checking system required for the load-unit method.

The greatest difficulty in the contract system appeared to be the lack of an organized plan. John W. Doherty, of the Belmont Construction Co., Philadelphia, who has handled many snow-removal contracts, insisted that work must begin as soon as the storm started. The laborers should be warmly clad and properly fed, if the best results are to be expected. The ordinary method of shoveling the snow from the full width of sidewalks into the middle of the street was condemned generally as making the problem of snow removal more difficult; the sidewalk snow should be piled on the outside one-third of the walk or along the property lines.

Snow Removal by the Street-Railway Companies—Martin Schreiber, Engineer of Maintenance-of-way of the Public Service Rys., Newark, N. J., explained the snow-fighting organization of a street-railway system of 865 miles of track. Before the winter season sets in, the officers of all departments meet and agree upon a snow-fighting campaign. Then all departments coöperate with a central organization which handles all the snow-removal work. Mr. Schreiber brought out clearly that the success of the street-railway forces was due to the compact and efficient organization, and he believed there was an opportunity for much greater coöperation between the city snow-removal forces and those of the street railways.

The use of spreader plows for cleaning wide strips each side of the street-car tracks was discussed and appeared to be feasible for the lighter snowfalls. These spreader plows have been used in Detroit and other cities for many years. Morris R. Sherrerd, Chief Engineer of the Board of Street and Water Commissioners, Newark, N. J., considered this a feasible way of opening streets and urged a closer coöperation between the cities and the street-railway companies.

Snow-Removal Machines—Various mechanical devices for melting or compressing snow were alluded to, but no experience with them was given, except by the engineers of the Pennsylvania R.R., who stated that a portable melting device made of a steam-heated gondola steel car had been used with success in Philadelphia. Dr.

Marie D. Equi, of Portland, Ore., the only lady attending the conference, was convinced that engineers were clever enough to invent a device after the nature of a steam-heated concrete mixer, which would solve the snow-removal problem once and for all; but there seemed to be considerable skepticism as to the success of any device that had ever been tried.

ORGANIZATION—A permanent Committee on Resolutions was appointed, consisting of Capt. Brooke, Chairman; J. T. Fetherston, Street Cleaning Commissioner, New York City; J. F. O'Toole, W. H. Connell, W. H. Lynch, of Harrisburg and R. B. Hamilton, Secretary and Treasurer of the Philadelphia Rapid Transit Co. It was recommended that another conference be held in the fall to make more definite plans.

NEWS NOTES

A 48-in. Water Main Burst in Brooklyn, N. Y., at 1 p.m., on Apr. 17, flooding many cellars in the vicinity. The water from the break was shut off at 2 p.m.

A Large Summer Hotel Burned at St. Andrews, N. B., on Apr. 11. The building, owned by the Canadian Pacific Ry., was recently renovated. It contained 500 rooms. The concrete walls still stand, but the building was gutted.

The Walls of a 20-Ft. Deep Cistern Caved In, at Woodhaven, L. I., on a brick mason working at the bottom, on Apr. 12. The cave-in was due to the failure of the shoring. The mason was killed.

A Surveying-Instrument Factory Burned on Apr. 11, at 814 Gates Ave., Brooklyn, N. Y. The plant belonged to F. E. Brandis' Sons Co., who now are temporarily situated at 843 Gates Ave.

A Fatal Rooming-House Fire in New York City cost the lives of 11 persons, on Apr. 17. The fire started at 2 a.m., in the basement. A large amount of inflammable rubbish in the stairwell caused the fire to gain rapid headway. The building was gutted.

A Fatal Hotel Fire in Allston, Mass., resulted in the death of seven persons on Apr. 14. The person sending in the alarm opened the door of the signal box, but neglected to pull down the signal hook. The mistake was discovered 10 minutes afterward, and the second call sent in.

No Danger Signals At An Approach of a Damaged Bridge near Whittier, Calif., caused the death of two automobilists, on Apr. 13. Warnings had been set at the Whittier end of the Pellessier Bridge, which spanned the San Jose Creek until washed out during the recent floods in Southern California, but the opposite approach was without signals. The automobile entered the bridge on the latter end and fell through the break to the creek bed 25 ft. below.

The "Height of Buildings" Bill covering New York City, was signed by Mayor Mitchel on Apr. 14, in spite of his uncertainty as to its constitutionality. The bill authorizes the Board of Estimate to district the city and enact ordinances fixing the permissible height of buildings. Before becoming effective, the bill must go to the Governor for signature.

The Plans for Cleveland's New Filtration Plant ("Eng. News," Mar. 19, p. 607) were approved by the Ohio State Board of Health on Apr. 16. The Board voted further that the city must provide for the disposal of waste from the mixing and coagulating basins, prior to discharge into Lake Erie or the Cuyahoga River, in a manner satisfactory to the Board.

A Municipal Milk-Handling and distributing plant has been made possible for the city of Jamestown, N. Y., by a legislative act amending the city charter accepted by the city and approved by the governor. The common council, on recommendation of the board of health may acquire such a plant after the taxpayers have voted in favor of the project.

Free Water Service in Indiana is prohibited under the Shively-Spencer act. We understand that this prohibition applies to water-works owned by municipalities as well as to those owned by private companies, and that it also compels municipalities owning their own water-works to appropriate money for fire protection and other municipal services from the general fund of the city. In response to a request for interpretation of the act as regards churches, the Public Service Commission of Indiana, we are informed by Joseph L. Reiley, Secretary, advised the city of Brazil, Ind., that although the city could not supply water free to churches it might make them a special rate.

Floods Again Threaten the Imperial Valley, Calif., according to a dispatch from Washington, D. C., Apr. 21. The Colorado River in southern Arizona is far above flood stage, and about 1000 ft. of the banks have been scoured out. The Imperial Valley irrigation canal is reported damaged and the situation is serious. Secretary of the Interior Lane called a conference of officers of the Reclamation Service to consider emergency measures. About $60,000 of the reclamation fund is available for emergency use.

Formal Breaking Through of the Cape Cod Canal—The waters of Cape Cod Bay on the east and Buzzards Bay on the west were formally intermingled by August Belmont, President of the Cape Cod Canal Construction Co., on Apr. 21. President Belmont stood on the sluiceway of Foley's dike, the west end of the central section which has been excavated below sea level by steam shovels (see "Engineering News," Feb. 19, 1914), and poured together the contents of two bottles, one of which contained the water of Buzzards Bay and the other that of Cape Cod Bay. Besides Mr. Belmont there were present J. W. Miller, Vice-President of the company and William Barclay Parsons, Chief Engineer. Mr. Belmont is reported as stating that the canal would probably be open for ships drawing not over 12 ft. by July 4. The full depth of the completed canal will be 25 ft. The dikes will not be destroyed until some time in June.

A Municipal-Railway Union has been formed by several cities in Ontario. It has petitioned the Provincial Cabinet (1) to empower the Hydroelectric Power Commission to proceed with the development of industrial power at Welland Canal and other points, (2) to adopt a proposed model agreement by which the Hydroelectric Power Commission and any municipality could contract for the construction and operation of "radial" (or interurban) electric railways, (3) to secure the provincial-government guarantee of the bonds of such "radial" lines, (4) to secure authorization of such bonds for 50-year terms without sinking-fund requirements for the first ten years, (5) to authorize the Hydroelectric Power Commission to divide the province into electoral zones, so that one municipality or portion thereof cannot hinder the construction of a line considered necessary by the others.

The Vote on the Purchase of the Water-Works of the Des Moines Water Co. by the city of Des Moines, taken on Mar. 30, resulted in a majority of about 2000 in favor of the purchase, but the vote taken at the same time for the issuance of bonds to cover the purchase price was 500 short of the majority required by law. The vote in favor of the purchase at a cost of approximately $3,400,000 was 11,362 to 9286; about one-sixth of the voters were women. The vote in favor of issuing bonds to the amount $2,380,000 for water-works purposes was 7535 to 4993, a majority of over 2500; but the law of the state requires that a vote on a bond issue must receive a majority of votes equal to a majority of all the votes cast at the last municipal election, which in this case would have required an affirmative vote of 8000.

Plans for Sewage Treatment for Hornell, N. Y., have been submitted to the State Department of Health for approval by Clyde Potts, of 30 Church St., New York. The Superintendent of Public Works of Hornell hopes that approval of the plans may be secured before long and that construction may be started by summer. The plans call for a pumping station, Imhoff tanks and sprinkling filters. The pumping station has a nominal capacity of 4,000,000 gal. per day to be provided with two 4,000,000-gal. vertical submerged centrifugal pumps electrically operated, and one 2,000,000-gal. vertical submerged pump also electrically operated, all the pumps being centrifugal. The pumps will be automatically controlled. The pumps will discharge into Imhoff tanks occupying a space of 60x100 ft. The tank effluent will flow to sprinkling filters 6 ft. in depth having an area of three-fourths of an acre. The filter effluent will flow into the Canisteo River.

New Ohio River Bridge at Pittsburgh, Penn.—All freight from the Pittsburgh, Cincinnati, Chicago & St. Louis Ry. which transferred to the Fort Wayne division of the Pennsylvania Lines west of Pittsburgh is carried by the Ohio Connecting Ry., which crosses the Ohio River over Brunots Island, just below the junction of the Monongahela and Allegheny Rivers. This railway has recently been double-tracked with the exception of the bridge over the Ohio River. The traffic has now increased so that it has been found necessary to erect

another bridge parallel to the old one. Some of the old piers are being utilized and a number of new ones are being built. Two new trusses of about 500 ft. span are being erected over the main and back channels of the Ohio. The approach on the south side consists of 14 deck trusses about 17 ft. deep and 200 ft. long. The viaduct approach on the north side consists of the ordinary columns and deck plate-girder spans. The bridge was designed under the direction of the Engineer of Bridges of the Pennsylvania Lines west of Pittsburgh, J. G. Bland.

The Ohio Conservancy Law was passed on as to its constitutionality by a decision rendered at Dayton, on Apr. 18, in the petition for the formation of a conservancy district in the Miami Valley.

When the arguments were presented to the court by the contesting counsel only nine of the ten judges were present, one of them being absent on account of sickness. Therefore, only nine judges participated in the decision rendered last Saturday. Of these nine judges, five affirmed the constitutional questions and the court's right of jurisdiction. Four voted to dismiss the petition, denying these rights.

This gave the petitioners the majority of the judges as the court was at that time constituted, but it did not give them a majority of the original court of ten judges. To avoid any dispute in the near future the court was asked to dismiss the petition that it might be taken to the Court of Appeals at once. The request was granted. The Court of Appeals meets in Dayton, May 25, and it is likely that the conservancy case will be the first upon its docket.

The Maier Water Bill Was Vetoed by Governor Glynn on Apr. 17. This Bill provided for the supervision of water companies by the State Conservation Commission, and was objected to by New York City on the ground that it would interfere with the use and development of the new Catskill water system. In his memorandum attached to his veto, the Governor commented upon the following provision:

No water-works corporation or municipality shall hereafter supply with water or extend its distributing mains for the purpose of supplying with water territory already supplied by the existing water-works system of a water-works corporation or municipality until the Commission shall have certified that public convenience and necessity require such supply or extension.

The Governor said: "This provision, in my judgment, is altogether too drastic. It seems to be broad enough to prevent a municipality from supplying itself with water in a territory already supplied by an existing water-works company, without the consent of the Conservation Commission. It would preclude such a municipality from furnishing its public schools, hospitals, police stations, and other public buildings, with necessary water, and from protecting itself by its own plants from the spread of conflagration, in that portion of its territory where existing corporations have pipe lines in service. . . . This provision, though general in its nature, seems to be peculiarly applicable to the City of New York."

The Hazard of Gutted Buildings—The danger of permitting the walls of buildings gutted by fire to remain standing longer than is absolutely necessary has been emphasized by many accidents, two of which are of recent occurrence.

On Mar. 27, the wind blew down the three upper stories of the west wall of the burned Missouri Athletic Club, at St. Louis, Mo., killing seven persons. These walls were not only permitted to stand eight days after the fire, but business was allowed to continue in an adjacent store, which was crushed by the falling walls with the loss of life just stated.

On Apr. 9, the west wall of the Independent Cloak Co.'s building in Toronto, Ont., collapsed upon a number of workmen who were removing débris resulting from a fire. Two were killed and four were seriously injured. This building burned in February. It is supposed that the men precipitated the collapse by removing some of the wall joists. The remainder of this wall was taken down by the fire department.

The insurance adjusters are at times responsible for keeping the walls standing after a fire. This happened after the destruction of the Congregational Church building in Montclair, N. J., shown on p. 793 of our last issue. Matters of insurance adjustment, however, should always yield to considerations of public safety. The municipal building department or fire department should exercise its authority to compel the prompt razing of such unsafe walls.

Simplified City Charters may now be adopted by cities of the second and third class in New York State, as the result of the Murtaugh-Sullivan "optional charter" bill passed and signed by Gov. Glynn. This measure was sought by a state conference of mayors and by the Municipal Government Association. Cities are given the right to select some one of seven certain forms of charter. Two forms provide for commission government; a third involves the city-manager scheme; a fourth permits a mayor and three or five councilmen to be elected at large; a fifth increases the council to nine; the sixth provides for electing a mayor and a common council from existing wards; the seventh option is for third-class cities and permits adoption of an existing second-class uniform-charter plan, but with lower salaries.

The short ballot is incorporated in all optional charters; the administrative offices, such as assessors, attorneys, engineers, treasurers, comptrollers, etc., are all made appointive. The mayors and councilmen, or their equivalents, have four-year terms—part being elected every two years. Salaries of mayors and councilmen are fixed according to population. All other salaries are fixed by city councils. County supervisors, judicial officers and boards of education are not affected. The act does not give complete new organization; except as to organic structure, all existing laws and ordinances remain in force until repealed. The bill goes into effect July 13.

The Formal Opening of Los Angeles Harbor took place on Apr. 11, when the new municipal pier, known as Morman Island Channel Wharf Pier A, was dedicated with appropriate ceremonies. This is a wood wharf 50 ft. wide and 1600 ft. long, founded on creosoted piles. It and the adjoining land carry a semi-fireproof shed 100x600 ft. in plan, which is leased to the Hawaiian-American Steamship Co. for a trans-pacific line. Other work going on in Los Angeles harbor, which is over 20 miles from the original city, but is now inside the city limits, comprises additional sheds, wharves and bulkheads in the inner, or old Wilmington harbor, all of which construction is wood or semi-fireproof, and dredging and reinforced-concrete pier work in the outer, or old San Pedro, harbor.

Water-Supply from Well-Pumping Plants in different parts of the city, as an auxiliary to the main supply, is now being furnished at Memphis, Tenn., this additional supply having been made necessary by the growth of the city. The first unit was completed in the spring of 1910; four were installed in 1911, seven in 1912, and three in 1913; so that there are now 15 units, each of 1,000,000 gal capacity, operating wells located along the entire length of the eastern boundary line of the city. These are on the Wills pumping system (patent applied for), in which the pumps take the water from the wells and force it directly into the mains under a required pressure at one operation. The pumps are operated by electric motors and are placed in concrete pits under the street, made accessible by manholes. A somewhat similar system at Rockford, Ill., was described in our issue of Aug. 21, 1913, but at Rockford each well has one pump for raising the water and a second for delivering it into the main.

This water-supply service at Memphis is in addition to the two other pumping systems; the tunnel system, with 14,000,000 gal. daily capacity and an air-lift plant of 5,000,000 gal. capacity. The available water-supply now is about 34,000,000 gal., while the normal capacity is less than 50% of this amount. The pumps are situated in different parts of the city. In case of fire, pressure can be maintained immediately by starting up a pump, and in case anything happens to either one of the three systems of pumping, the other two could take care of the demand. In regard to the decrease of supply in older wells, the water department endeavors to maintain the supply of the tunnel system by boring new wells to take the place of deficient old ones. Four new wells in this section were bored during 1913. However, the Wills pumping system was installed to take care of the increasing population and to afford better fire protection. While a few other cities have employed this pumping system, not much has been heard of it as the inventor has been working on a patent. It is the invention of Wirt J. Wills, General Superintendent of the Memphis Artesian Water Department.

PERSONALS

Mr. N. M. Johnson, Assoc. M. Am. Soc. C. E., of Northfield, Vt., has been appointed City Engineer of Montpelier, Vt.

Mr. George W. Boschke has resigned as Chief Engineer of the Oregon-Washington R.R. & Navigation Co., effective May 1.

Mr. W. L. Darden has been appointed Engineer of Buildings of the Seaboard Air Line Ry., with headquarters at Portsmouth, Va.

Mr. H. C. Lothholz, Assistant Engineer of Design of the Chicago, Milwaukee & St. Paul Ry., Chicago, Ill., has been promoted to be Engineer of Design.

Mr. J. H. Prior, Engineer of Design of the Chicago, Milwaukee & St. Paul Ry., has resigned to become Assistant Chief Engineer of the Illinois Public Utilities Commission.

Mr. James A. Hooke, Assistant Sewer Commissioner of St. Louis, Mo., has been appointed Sewer Commissioner to succeed Mr. Charles A. Moreno, resigned as noted in our issue Apr. 9.

Mr. E. A. Frink, M. Am. Soc. C. E., Bridge Engineer of the Seaboard Air Line Ry., Portsmouth, Va., has been promoted to be Principal Assistant Engineer, succeeding Mr. E. G. Bagwell, promoted.

Mr. Frederick B. Cook has resigned as Vice-President of the Safety Scaffolding Co., of New York City and Atlanta, Ga., to become Vice-President and Manager of the American Mailing Device Corporation, New York City.

Mr. J. B. Myers, Division Engineer of the Baltimore & Ohio R.R., at Cumberland, Md., has been promoted to be District Engineer of Maintenance-of-way at Baltimore, Md., succeeding Mr. S. A. Jordan, promoted, as noted elsewhere.

Mr. Francis T. Bowles, formerly Chief Naval Constructor, U. S. N., has resigned as President of the Fore River Shipbuilding Corporation, Quincy, Mass., effective July 1. He resigned from the Navy in 1903 to accept his present office.

Mr. P. J. Carter, Office Engineer of the Western lines of the Atchison, Topeka & Santa Fé Ry., at Amarillo, Tex., has been appointed Assistant Engineer in charge of construction of the railway's new shops and yards at Albuquerque, N. M.

Mr. H. W. Davies has been appointed Assistant to the President and General Manager of the Pacific & Idaho Northern Ry., with headquarters at New Meadows, Idaho. He was formerly with the Southern Ry. and the Norfolk Southern R.R.

Mr. S. A. Jordan, District Engineer of Maintenance-of-way of the Baltimore & Ohio R.R., at Baltimore, Md., has been promoted to be Superintendent of the Shenandoah division, with office at Winchester, Va., succeeding Mr. G. D. Brooke, transferred.

Mr. H. Hobart Porter, M. Am. Soc. C. E., of Sanderson & Porter, Engineers, New York City, has been elected President of the American Water-Works & Electric Co., which is the reorganized American Water-Works & Guarantee Co., of Pittsburgh, Penn.

Mr. Louis Chevalier, Assoc. M. Am. Soc. C. E., recently Engineer, Stillman-Delehanty-Ferris Co., Jersey City, N. J., has been appointed Bridge Engineer of the Seaboard Air Line Ry., with headquarters at Portsmouth, Va., succeeding Mr. E. A. Frink, M. Am. Soc. C. E., promoted, as noted elsewhere.

Count Jacques de Lesseps, son of Ferdinand de Lesseps, who was the promoter and Chief Engineer of the original Panama Canal, sailed from New York City Apr. 11 for Colon, Panama. Count de Lesseps has never before visited the scene of his father's exploits. He is an aviator of the French Army.

Mr. Carl H. Booth has retired from the Shuman-Booth Co., Chicago, Ill., to become Vice-President of the Metallurgic Engineering Co., also of Chicago. The business of the Shuman-Booth Co. will be continued under the firm name of the Shuman Advertising Co., of which Mr. R. R. Shuman is President.

Mr. F. O. Dufour, Assoc. M. Am. Soc. C. E., Consulting Engineer, of Athens, Penn., has been appointed Senior Structural Engineer, Central district, Division of Valuation, Interstate Commerce Commission, with headquarters at Chicago, Ill. Mr. Dufour was formerly Construction Engineer with Mr. D. A. Keefe, Consulting Engineer, Athens, Penn. Previous to June, 1913, he was Assistant Professor of structural engineering at the University of Illinois.

Mr. Spencer J. Stewart, Assoc. M. Am. Soc. C. E., recently Division Engineer, New York State Highway Department, has been convicted of conspiracy to defraud the state in connection with the construction of a state road in Long Island. The sentence of the court has not been pronounced. Besides Mr. Stewart his Assistant Engineer, Mr. Leigh Roberts, the President of the Suffolk Contracting Co., Mr. Daniel E. Lynch, and two other members of the contracting company were indicted and convicted on the same charge.

Mr. Paul Hannagan, Alderman and Commissioner of Streets of Lawrence, Mass., has been appointed Consulting Engineer in charge of street construction, Boston, Mass., at a salary of $5000 per annum. Mayor Curley of Boston has announced a pavement policy in which the surfacing of many miles of private alleys is a prominent feature. The mayor has also recently discharged several of the engineers in the municipal service, and cut the salaries of many more, as noted in our issue of Mar. 12, p. 589. It is announced that Alderman Hannagan will devote a part of his time to assisting Mr. Louis K. Rourke, M. Am. Soc. C. E., whose administration as Commissioner of Public Works has been a notable one for efficiency and work done.

Mr. Milan V. Ayres, M. Am. Inst. E. E., recently Statistician for Ford, Bacon & Davis, Consulting Engineers, New York City, has been appointed Senior Electrical Engineer of the Eastern district, Division of Valuation, Interstate Commerce Commission, with headquarters at Washington, D. C. Mr. Ayres was born in Kansas in 1875. He graduated in electrical engineering at the Massachusetts Institute of Technology in 1898 and for a few years was employed by the General Electric Co., Schenectady, N. Y., in the testing department and in the design of alternating-current machinery. From 1902 to 1911 he was Electrical and Mechanical Engineer of the Boston & Worcester Street Railway Co., and afterward Assistant to the General Manager of the Rockland Light & Power Co., Nyack, N. Y., and Chief Engineer of the Mobile Light & Railroad Co., Mobile, Ala. He has been with Ford, Bacon & Davis since 1912.

Mr. Fred W. Ranno, recently Superintendent for Kilpatrick Bros., General Contractors, on track elevation and construction work, Wichita (Kan.) Union Terminal Ry., has been appointed Senior Civil Engineer, Eastern district, Division of Valuation, Interstate Commerce Commission, with office at Washington, D. C. Mr. Ranno is a native of Vermont and graduated from the Massachusetts Institute of Technology in 1889. He has been in railway work nearly all the time since leaving college, first with the Pennsylvania R.R. and for seven years with the Lake Shore & Michigan Southern Ry., chiefly as Resident Engineer on construction in and around Chicago, Ill. In 1897 he was made Assistant Engineer in charge of reconstruction of the Southern Indiana Ry. (now the Chicago, Terre Haute & Southeastern Ry.). Later he was promoted to be Engineer of Maintenance-of-way. From 1907 to 1911 he was Assistant Engineer of the Union Pacific Ry., and the following two years Principal Assistant Engineer of the Missouri, Oklahoma & Gulf Ry.

OBITUARY

Howard E. Arthur, M. Am. Soc. C. E., died Apr. 18, at his home in Big Hollow, N. Y. Mr. Arthur was formerly Chief Engineer of the Mosher Manufacturing Co., Dallas, Tex.

Sanford Bilyeu, Consulting Electrical Engineer of the Philadelphia Electrical Co., of Philadelphia, Penn., died Apr. 14, at his home in that city. He was a native of Philadelphia and over 70 years old.

Robert T. Frazier, First Assistant Commissioner of Patents, died Apr. 19 at the Johns Hopkins Hospital, Baltimore, Md. He was 51 years old and a native of Tennessee. He was a graduate of the United States Naval Academy, class of 1883. Mr. Frazier was appointed Assistant Commissioner of Patents by President Wilson in June, 1913.

William H. Dean, a young civil engineer of Williamsburg, Penn., committed suicide Apr. 16, at a hotel in Philadelphia. He was formerly employed as a draftsman in the Pennsylvania State Highway Department, the United States Bureau of Drainage Investigations, the Bureau of Public Works of the Philippine Islands and the Atlantic Gulf & Pacific Co., of Manila, P. I. He was a member of the Philippine Engineers' Society and of the Engineers' Society of Pennsylvania.

Joseph Ditto, Assistant Engineer of the Department of Public Works of the city of Buffalo, N. Y., in charge of dock and bridge work, died Apr. 12, aged 47 years. He was a son of John Ditto, for many years City Engineer of Buffalo. He did not attend college because of a handicap of poor hearing, but this affliction made him a deeper student in many ways. In 1890 he entered the city engineering department as a rodman and was successively promoted to be Assistant Engineer in 1902.

Aaron J. Zabriskie, for many years Secretary and Engineer of the New York Monument Commission, died Apr. 15, at his home in Jersey City, N. J. Mr. Zabriskie graduated in civil engineering at the Rensselear Polytechnic Institute in 1876. For several years he was in railway construction work on the Erie R.R. and the West Shore R.R. In 1888 he was appointed Secretary of the New York Monument Commission, in which position he had charge of the design and construction of the foundations and bases of all the Civil War monuments erected to New York State soldiers on the southern battlefields.

Sir William Whyte, for many years Vice-President of the Canadian Pacific Ry., died at Coronado Beach, Calif., Apr. 14. He was born in Scotland in 1843. After a year's experience in railway work in his native country he went to Canada in 1863 and for 20 years was in the service of the Grand Trunk Ry. He became connected with subsidiaries of the Canadian Pacific Ry. in the early days of the consolidation of the system and for 25 years held various positions in the operating department from General Superintendent to Vice-President. He retired in 1911.

Thomas H. Johnson, M. Am. Soc. C. E., for years Consulting Engineer of the Pennsylvania R.R. lines West of Pittsburgh, died Apr. 16, at his home in Pittsburgh, Penn., aged 73 years. He was born at Coshocton, Ohio, Jan. 12, 1841. He was educated at Jefferson College in Pennsylvania and entered the employ of the Pittsburgh & Steubenville R.R. as a rodman in 1863. Until 1875 he was in railway engineering for various lines in Pennsylvania and Ohio, which ultimately became parts of the Pennsylvania system. For three years he was in private practice as an architect and civil engineer at Columbus, Ohio, and for five years was Engineer for the contractors who built the Indiana state house at Indianapolis. Mr. Johnson returned to railway work in 1883 as Principal Assistant Engineer of the Pittsburgh, Cincinnati & St. Louis Ry. He continued in this position and as Chief Engineer until 1901, since which time he has been Consulting Engineer of the Pennsylvania Lines West of Pittsburgh.

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